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The Dissertation Committee for The University of Texas at Brownsville Certifies that this is the
Approved Version of the Following Dissertation:

A Case Study of Three Mathematics Teachers

By

Sandra Quiroz

A Dissertation Presented to the Graduate Faculty of the College of Education in Partial
Fulfillment of the Requirements for the Degree of

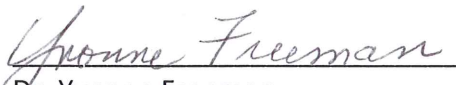
Doctor of Education

In the Field of Curriculum and Instruction

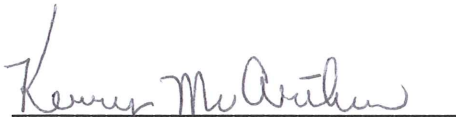
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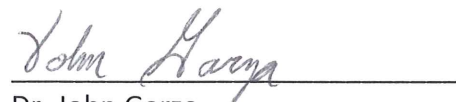
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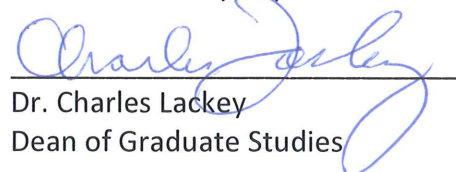
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(April, 2013)

Cross Case Analysis of Three Middle School Mathematics Teachers

A Dissertation

Presented to the Faculty of the College of Education

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In Partial Fulfillment

of the Requirements for the Degree of

Doctorate in Education in Curriculum and Instruction

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Sandra Quiroz

DEDICATION

This work is dedicated to all of those who dedicate their time to helping these learners achieve academic success.

ACKNOWLEDGMENTS

I want to thank all of the people who supported me and encouraged me throughout this process. First, I would like to thank my family who believed in me and encouraged me to continue. I want to express my heartfelt appreciation to my husband who regardless of the number of revisions, stood by me through the long days and late nights and reassured me that I could finish this dissertation. I also want to thank my best friend who never tired of reading my drafts and provided constructive criticism. It was because of their faith in me that I persevered and successfully earned this degree.

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ABSTRACT

This cross-case analysis was designed to investigate the instructional practices middle school mathematics teachers use in classes with English language learners (ELLs); how the different practices result in differential student achievement; the types of professional development middle school mathematics teachers attend; and what effect the mathematics teachers' academic background have on the academic achievement of ELLs. The study was facilitated by the use of data from lesson plans, observations, interviews, academic background, and professional development sessions for three seventh-grade mathematics teachers and their students' proficiency on the seventh-grade mathematics state achievement.

Investigation of the lesson plans, observations and classroom culture led to three conclusions on the importance of creating appropriate lesson plans, implementing those lesson plans and creating respectful yet challenging learning environments to foster the learning of diverse students. Examination of the mathematics teachers' academic background and professional development established a positive relationship between academic background and professional sessions attended and student-achievement outcomes. The relationships were significant predictors of achievement in mathematics. Results indicate that mathematics teachers of second language learners should learn and implement teaching and learning strategies that support literacy development and enhance the understanding of mathematics.

Keywords: English language learners, middle school mathematics, secondary mathematics classrooms, literacy and mathematics, disciplinary literacy

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Chapter 1: Introduction to the Study

Background

One of the biggest challenges has been the education of children from diverse cultures, particularly Hispanic students who come to U. S. schools with little or no knowledge of the English language. This group, English Language Learners (ELLs), coined by Garcia (2009) as “emergent bilinguals,” is the fastest growing minority in the United States. Children whose first language is other than English have often been referred to as English Language Learners (ELLs), Limited English Proficient (LEP) students, English to Speakers of Other Languages (ESOL), and English is a New Language (ENL) students; however, for the purposes of this paper, ELLs will be used in reference to students whose first language is not English.

An increasing number of school-age children in the United States are Hispanic students that constitute the majority of many urban school districts in the country (National Center for Educational Statistics, 2004). Hispanic students also constitute the largest group of English language learners (ELLs). Furthermore, Hispanic students have the lowest levels of education and the highest dropout rate. Hispanic students’ educational aspirations and academic performance in science, mathematics, and reading are significantly lower than those of their Anglo counterparts (Gandara and Contreras, 2009). ELLs’ achievement scores in mathematics on tests such as the National Assessment of Educational Progress (NAEP) fall below those of Anglo-Americans and African American students (Gandara and Contreras, 2009). Average mathematics scores were higher in 2009 than in 2008 for both Hispanic and White eighth-graders by 2 points, the gap widened from 24 to 26 points (National Center for Education Statistics [NCES],

2011). Gandara & Contreras (2009) also observed substantial racial/ethnic gaps in mathematics performance. These figures may explain why there is such an over representation of Rio Grande Valley Hispanic students enrolled in remedial classes at local universities and colleges. Public school administrators are at a loss as to how to help ELLs reach academic success in the area of mathematics.

Although all subgroups made gains in mathematics and science during elementary school, the rates of growth for ELLs varied and some of the achievement gaps widened at the secondary level. In 2010, the Public Education Information Management System (PEIMS) listed Spanish speakers as composing 91% or 744, 949 of the ELL population in Texas schools. The state of Texas Education Agency (TEA) also reports math passing rates more than doubled between 2003 and 2011, rising from 44 percent in 2003 to 90 percent in the all student group. While the ELLs have made some gains over the past eight years, their performance on the mathematics Texas Assessment of Knowledge and Skills (TAKS) is still dramatically behind the all student group. At the seventh grade, 61% of ELLs met the mathematics TAKS standard in comparison to 81% for the all student group. Students in the eleventh grade were 90% proficient in mathematics while English language learners (ELLs) students fared 61%.

The aforementioned figures along with the proficiency rates for retest students and college entrance exams may explain why there is such an over representation of Hispanic students enrolled in at local universities and colleges in the Rio Grande Valley. A 2010 college readiness report published by the national ACT (American College Test) office delineated only 26% of Hispanic students who took the mathematics section of the ACT as having the necessary skills to do well in college algebra. This percentage is

dismal in comparison with the 63% preparedness of white students who took the same exam.

A recent report from the Migration Policy Institute (2010) reported the enrollment of ELLs in U.S. schools comprised approximately 10 percent or 4.9 million of the total student enrollment between 2007 and 2008. In 2008, Hispanics, the largest growing school age group, made up 48% of public school students in California, 46% in Texas, and about 20% in New York (Garcia, Kleifgen & Flachi, 2008; Gandara & Contreras, 2009; Garcia, 2010). Of the total PreK-12 enrollment in Texas, 4.6 million, over 700,000 students were classified as ELLs, a 38.4 % increase since the 1997-1998 school year (Migrant Policy Institute, 2010). Public schools in Texas received burgeoning numbers of ELLs, second only to the state of California.

Many ELLs entering American schools are at high risk for academic failure (Ruiz-de-Velasco, Fix, & Clewell, 2000). Fifty percent of Latino students do not graduate from high school (Garcia, Kleifgen & Flachi, 2008; Gandara & Contreras, 2009; Garcia, 2010). As noted by Vasudevan and Campano (2009), ELLs leave high school as early as the ninth and tenth grade. In their study, Vasudevan and Campano (2006) delineate probable causes for the premature exit of ELLs. The authors cite the contemporary realities facing adolescents in U. S. schools. In many cases, these students attend overcrowded, under supplied classrooms and use outdated texts.

Along with the realities facing youth in U.S. schools, they and their teachers must also grapple the new standards for school mathematics that describe an ambitious and comprehensive set of goals for mathematics instruction. The first five standards present goals in the mathematical content areas of numbers and operations, algebra, geometry,

measurement, and data analysis and probability. The second five describe goals for the processes of problem solving, reasoning and proof, connections, communication, and representation. Together, the standards describe the basic skills and understandings that students will need to function effectively in the twenty-first century. Within the standards the National Council for Teachers of Mathematics (NCTM) included six principles for school mathematics address that overarching themes: (1) equity, curriculum, teaching, learning, assessment, and technology. Reform is about children and thinking.

Despite the steadily increasing population of second language learners in U.S. schools, the educational reform movement mandated by the No Child Left Behind (NCLB, 2001) that ELLs are to be “included for purposes of equal opportunity, accountability, and representation” (Hofstetter, 2003 p.1) and the mathematics reforms adopted by the NCTM have failed to meet the needs of these students and has typically underestimated the extent to which linguistic diversity has become commonplace in U.S. classrooms.

Despite the low performance of ELLs on mathematics there has been little research addressing the needs of second language learners in mathematics classrooms (Moschkovich, 2002; Nasir, Hand, and Taylor, 2008; Vasudevan and Campano, 2006). Moschkovich (2002) states that early studies of ELLs learning mathematics framed the challenges that students in bilingual programs faced in terms of solving word problems, understanding vocabulary, or translating from English to mathematical symbols. Perhaps more than any other subject, teaching and learning mathematics depends on language. Mathematics is about relationships: relationships between numbers, between categories, between geometric forms, between variables and so on. In general, these relationships are

abstract in nature and can only be brought into being through language. Understanding and expressing abstract ideas are the last set of language skills an English language learner will acquire.

Statement of the Problem

The number of English language learners in U.S. public schools is steadily increasing due in part to movement of people both physically and ideologically occasioned by wars, poverty, globalization, new technologies, the creation of new economic trading blocks, new socioeconomic and sociopolitical organizations (Garcia, 2009). Furthermore, increasing numbers of students come to public schools with different life experiences and cultural backgrounds. These rising numbers have created challenges for educators to devise methods of meeting the needs of English Language Learners, the fastest growing portion of the K-12 student population, (Garcia, Kleifgen & Flachi, 2008; Goldenberg, 2008). The increased enrollment coupled with the current consensus of scholars that, “research has failed to provide a complete answer to what constitutes high quality instruction for language minority students” (August & Shanahan, 2006) provide evidence of the great need for research in this area. To build a research base on effective instructional models for these students, studies on instructional models on student learning is necessary. One area that warrants particular attention is middle school mathematics. Additionally, it is imperative for literacy educators to become cognizant of the instructional models being implemented for English language learners in mathematics classrooms so that they may reflect on these models’ effect on minority language students’ achievement in mathematics classrooms.

Traditionally, mathematics classrooms have been places where only a small, select group of individuals, who are generally White and middle- or upper-class, has found success (Ladson-Billings, 1997). This has left a majority of students, most notably students of color, those from lower-income households, and ELLs with limited access to mathematical attainment. Quite often students who are not in the upper echelon of mathematics classes are faced with the drilling of basic skills in lieu of the development of higher order thinking skills (Tate, 1995). As a result, these students are often relegated to lower-level mathematics courses with lower academic expectations, which can limit their future academic access and potential (Gutierrez, 2002). Mathematics tends to be a gatekeeper and a sieve for sorting students for future success, life experiences, and incorporation into society (Moses & Cobb, 2001; Stone, 1998). The result for many students from low socioeconomic or racial/ethnic minority households is unequal access to college preparatory mathematics (Gamoran & Hannigan, 2000);

Purpose of Study

The purpose of this study is to determine the pedagogical and instructional practices and types of professional development middle school mathematics teachers need to be effective in meeting the needs of English language learners in the mathematics classroom. Additionally, this study proposes to examine the effects of mathematics teachers' academic background on the academic achievement of second language learners through case studies of three middle school mathematics teachers in a school district in close proximity to the Texas/Mexico border. As a lens for the study, the researcher will incorporate Vygotsky's (1931/1997) *sociocultural theory* to explain how individual mental functioning is related to cultural, institutional, and historical context.

Hence, the focus of the sociocultural perspective is on the roles that participation in the social interactions and culturally organized activities play in learning mathematic concepts.

Research Questions

I have developed two main research questions and one sub question:

Research Question 1 What instructional practices do middle school mathematics teachers in this cross case study use in classes with ELLs? Sub-question: How do their different practices result in differential student achievement between mainstream students and ELLs?

Research Question 2 What effect does the academic background and professional development of mathematics teachers in this cross case study have on the academic achievement of their second language learners?

Hypothesis

If middle school mathematics teachers have the appropriate academic background and professional development on best practices and strategies for teaching English language learners, they can institute such practices to improve the performance of English language learners in the middle school mathematics classroom and ultimately on standardized exams.

Theoretical Framework for the Study

Major theories in second language acquisition, sociocultural theories, and adult learning theories support this dissertation including theories developed by Lindeman (1926); Hunt (1975), Vygotsky (1979), Oja (1980), Cummins (1981), Krashen (1981), Schumann (1978) and Knowles (1973, 1989, 1990). This study adopts a sociocultural

perspective, within which learning, including second language acquisition (SLA), is considered to be an inseparable aspect of participation in community discourse practices (Moschkovich, 2002; Nasir & Hand, 2006; Nasir, Hand and; Taylor, 2008; Haneda, 2008). Gee (1996) specified two types of Discourse, primary and secondary. The first type is the Discourses people develop early in their socialization with members of particular families and through the sociocultural environment they are reared in. Gee (1996) theorized that *primary discourses* form people's understandings of who they are and their values and beliefs. Additionally, *primary discourses* construct the base within which we acquire or resist later *discourses*. *Secondary discourses*, are those to which people are apprenticed as part of their socializations within various local, state, national groups and institutions outside early home and peer-group socialization—for example, churches, gangs, schools, offices. These Discourses constitute the recognizability and meaningfulness of public or more formal acts (p. 137). The relationship between Discourse, culture and learning has been a topic of discussion for many decades and has been tied to socioculutral theories.

Sociocultural Theories

Sociocultural theories are rooted in the work of Lev Vygotsky (1979), a soviet psychologist of the early 1900s, who articulated a view of culture not only as a system of meaning carried across generations, but also as constantly being created and recreated in local contexts. According to Vygotsky, understanding learning requires a focus on how individuals participate in particular activities, and how they draw on artifacts, tools, and others in social settings to solve local problems. Sociocultural perspectives examine the roles of social and cultural processes as mediators of human activity and thought.

Additionally, sociocultural theories locate the fundamental unit of analysis for the examination of human behavior as activity, or cultural practices. This notion of activity offers a unit of analysis that affords an understanding of the complex intertwining of the individual and the cultural in development.

Based on Vygotsky's (1979) social learning theory another area interrelated with sociocultural learning, and pertinent to this study is the theory of situated cognition. Emerging from anthropology, sociology, and cognitive theory, situated cognition theory represents a major shift in learning theory. Situated cognition theory suggests that learning is naturally tied to authentic activity, context, and culture (Barton, Hamilton and Ivanic, 2000; Brown, Collins, and Duguid, 1989; Lave and Wenger, 1989). Situated cognition poses that knowing is inseparable from doing (Brown, Collins, & Duguid, 1989) and argues that all knowledge is situated in activity bound to social, cultural and physical contexts (Greeno & Moore, 1993). Barton, Hamilton and Ivanic (2000) tie situated cognition to literacies and argue that "Literacy practices are patterned by social institutions and power relations, and some literacies are more dominant, visible and influential than others" (p.12).

Barton and Hamilton (2000) describe literacy practices as "the general cultural ways of utilizing written language which people draw upon in their lives. In the simplest sense literacy practices are what people do with literacy" (p. 8). Literacy practices involve values, attitudes, feelings, and social relationships. They have to do with how people in a particular culture construct literacy, how they talk about literacy and make sense of it.

In situated approaches, students collaborate with one another and their instructor toward some shared understanding. Instructors who advocate such approaches believe there is a culture of learning that can be cultivated. In other words, students can process concepts and information more thoroughly when multiple opinions, perspectives, or beliefs must be accounted for across a group. Under this assumption, which requires an epistemological shift from empiricism, situated cognition theorists suggest a model of knowledge and learning that promotes the view that most learning occurs naturally through activities, contexts, or cultures. Therefore, learning is seen in terms of an individual's increasingly effective performance across situations rather than in terms of an accumulation of knowledge, since what is known is co-determined by the agent and the context. Lave & Wenger (1991) describe this type of learning as dynamic communities of practice. The authors argue that teacher and student are seen as a critical element of situated cognition theory's sociological view of learning. Thus, learning not only involves teacher and student but also assorted others.

Much research has been written about the link between Discourses, race, culture and learning; however, the struggle to make sense of this intersection has positioned the underachievement of minority students as the problem and has sought to both explain its genesis and offer possible solutions (Nasir & Hand, 2006). In the past decades there has been growing recognition of the fundamentally social nature of learning and cognition (Nair and Hand, 2006; Haneda, 2008). Proponents of the social nature of learning and cognition argue that social and cultural processes are central to learning and that local activity settings in adolescents' learning are critical to learning. Thus, sociocultural studies of adolescent literacies investigations, including mathematical literacy, lie in

“adolescents’ social, cultural, and intellectual worlds, literacy policies and standardized curricula often mired in discourse of student deficit” (Lave and Wenger, 1991; Vasudevan and Campano, 2009 p. 313).

Gee (2000) argues that meaning for language is created as people use it in association with situated meanings, cultural models, and the sociocultural groups that socialize learners into discourse communities. So, to join a new discourse community is to have the potential to acquire new language resources, new practices and new identities (Sfard & Prusak, 2005). Through participation in joint activities in the context of schooling, students become socialized into the language and social practices of the classroom (Moschkovich, 2002; Nasir & Hand, 2006; Nasir, Hand and; Taylor, 2008; Haneda, 2008). Lerman (2001) and Lave and Wenger (1991) maintain that learning is about becoming a participant of a community of practices and participating in practices. Indeed, language learning is dependent on access to the social practices through which learning and teaching are linguistically enacted. This highlights the importance of providing ELLs with appropriate participatory and learning opportunities in classrooms such as cognitive apprenticeships or novice/master relationships. Brown, Collins, & Duguid (1989) argue that cognitive apprenticeships must include the enculturation of students into authentic practices through activity and social interaction. To do so, an instructor must be cognizant of the four dimensions: content, methods, sequence, and sociology when planning instruction. The instructor must embed learning in activity and make deliberate the use of the social and physical contexts present in the classroom (Brown, Collins, & Duguid, 1989). The technique draws on the principles of Legitimate Peripheral Participation (Lave & Wenger, 1991) and reciprocal teaching (Palinscar &

Brown, 1984; 1989) in that a more knowledgeable other, a teacher, engages in a task with a more novice other, a learner, by describing their own thoughts as they work on the task, providing "just in time" scaffolding, modeling expert behaviors, and encouraging reflection.

Second Language Acquisition Theories

The linguistic and cognitive demands experienced by ELLs are explained by second language acquisition theories. Current theories of second language acquisition are based on years of research in a wide variety of fields, including linguistics, psychology, sociology, anthropology, and neurolinguistics (Freeman & Freeman, 2001). One concept endorsed by most current theorists is that of a continuum of learning—that is, predictable and sequential stages of language development, in which the learner progresses from no knowledge of the new language to a level of competency closely resembling that of a native speaker.

An important contribution to second language acquisition is Krashen's (1981) theory of second language acquisition, which consists of five main hypotheses: acquisition learning hypothesis, the monitor hypothesis, the natural order hypothesis, the input hypothesis, and the affective filter hypothesis.

Underlining acquisition/learning hypothesis is the premise the two independent systems Krashen (1981) has identified for learning or acquiring a second language. The first system is acquisition, a product of a subconscious process very similar to the process children undergo when they acquire their mother language. This process requires meaningful interaction with the target language. The second, the learned system is the

product of formal instruction and comprises a conscious process that results in conscious knowledge about the language.

The natural order hypothesis suggests that the acquisition of language follows a predictable natural order. Krashen (1981) maintains that in any give language some grammatical structures tend to be acquired earlier than others. This idea reflects Chomsky's notion that individuals have a built-in language acquisition device which enables individuals to understand and acquire language within the first years of their lives.

Krashen's (1981) Monitor Hypothesis explains how acquisition and learning are interrelated and how one influences the other. According to Krashen (1981), the acquisition system is the utterance initiator, while the learning system performs the role of the 'monitor' or the 'editor'. The 'monitor' acts in a planning, editing and correcting function when three specific conditions are met: that is, the second language learner has sufficient time at his disposal, he focuses on form or thinks about correctness, and he knows the natural order of grammar.

Through the "comprehensible input" hypothesis, Krashen (1981) argues that learners acquire language by understanding language that is a "little beyond" their current level of competence (p. 20). Krashen describes this theory in an equation. If i is the language learner's current level of competence in the second language, then $i + 1$ is the next immediate step along the development continuum. Therefore, if the goal is to assist the language learner's progress in his task, it is essential to provide the student/learner with comprehensible input $[i + 1]$.

Another hypothesis is the Affective Filter Hypothesis (Krashen, 1981; Krashen & Terrell, 1983). This hypothesis suggests that an individual's emotions can directly interfere or assist in the learning of a new language. According to Krashen (1981), input is the principal variable in second language acquisition. Affective variables such as motivation, self-confidence and anxiety, act to impede or facilitate the delivery of input to the language acquisition device. The filter hypothesis explains why it is possible for an acquirer to obtain a great deal of comprehensible input, yet not acquire native speaker proficiency.

Like Krashen, Schumann's (1978) acculturation model of second language acquisition (SLA) contends that learners will succeed in SLA only to the extent they acculturate into the group that speaks the target language natively. Schumann (1978) separates instruction from acculturation, and claims that instruction is a minor variable in the SLA process compared to acculturation. Instead he emphasizes the sociocultural factors that act on the language learner and on the fact that the greater the social distance between two cultures, the greater the difficulty the learner will have in learning the second language, and conversely, the smaller the social distance, the better the learning situation will be.

In his model Schumann identified eight factors that influence social distance. The factors refer to a group rather than to individual distance. The first factor, social distance considers the degree of equality (subordination or domination) among groups. Integration pattern, the second variable, reflects the desire of both the target language and language learner groups to assimilate. The third feature is enclosure that refers to the degree to which the language learner group exists independently from the target group. Next, the

cohesiveness of the group influences second language learning. A fifth characteristic of the model is size of the group that influences second language learning in that smaller groups are more readily assimilated into the target language group. The seventh aspect is cultural congruence that reflects the degree to which the two groups' cultures are considered to be similar and to share aspects. An important attribute for acquiring a second language is attitude. Attitude refers to several affective factors: the feeling of language confusion and culture, or the second language learner's motivation to learn the target language. The final factor is the intended length of residence that refers to the amount of time the second language learner intends to remain with the target language group.

In addition to identifying eight factors that influence social distance, Schumann (1978) introduces a second variable that can be used to predict the degree of language acquisition: psychological distance. By Schumann's (1978) definition, psychological distance is the distance between the learner and the target language group. He identifies three main characteristics that determine the psychological distance a second learner has from the target language and culture: motivation, attitude, and culture shock. Schumann (1978) points out that these factors come into play whether the social distance is negative or positive.

Conversational Fluency and Academic Language

One of the theories that has had a direct influence on classroom instruction is Cummins's (2008) distinction between two types of language proficiency: conversational fluency and academic language proficiency refer to daily conversational face to face interactions where meaning is supported by contextual cues in a meaningful social

setting. Within this setting, language is context embedded. The student develops a basic vocabulary of tangible objects used in everyday life. Within six months to two years, the student can speak English on a conversational level, but has not yet developed the academic language necessary to succeed in the classroom. The student's ability to communicate in the second language in everyday conversations is not yet sufficient for understanding and using academic terms in an academic context, particularly in reform-oriented mathematics classrooms where English language learners are expected to participate in communities that practice oral and written discourses to explain solution processes, describe conjectures and prove conclusions.

The amount of time to develop academic language is dependent on many variables such as language proficiency level, age and time of arrival at school, level of academic proficiency in the native language, and the degree of support for achieving academic proficiency. At the proficiency level, the student demonstrates the ability to make complex meanings in a cognitively challenging, context-reduced setting (Cummins, 1981, 1996; Hakuta, Butler and Witt, 2000; Thomas and Collier, 1997).

Cummins (2008) further developed his work with the addition of the Quadrants Model, a representation of the components of the conversational and academic distinction in language development. This model provides a means of describing the linguistic and cognitive demands experienced by English language learners. In the quadrant, language tasks range in difficulty along two continua, one from cognitively undemanding to cognitively demanding and the other from context-embedded to context-reduced. Cognitively undemanding communication requires a minimal amount of abstract or critical thinking. Examples are a conversation on the playground, or simple yes/no

questions in the classroom. A context-embedded task is one in which the student needs access to a range of additional visual and oral cues in order to make meaning of what is presented.

Based on the second language acquisition theorists, there is variation in the contexts within which both individuals and groups acquire a second language. Educators face the challenge of understanding those contexts that motivate individuals, the relationship between the first and second languages, and the academic environment, including the different demands placed on the second language learner in a classroom setting. Teachers understanding of the second language acquisition process will help to guide instructional strategies toward ways to accommodate second language learners in various development sequences.

Adult Education Theories

The third area of the conceptual underpinnings is adult learning theories. Research on knowledge and thinking in conjunction with student learning has taken a center stage for many decades; however, less attention has been placed on teachers either in creating experiences consistent with the reform agenda or on how they themselves learn new ways of teaching (Putnam and Borko, 2000). In mathematics instruction the curriculum and teaching standards have come to reflect a model of mathematics learning that emphasizes discourse and communication (NCTM, 2010). Mathematics instruction has shifted from primarily silent and individual activities to more verbal and social ones. In reform-oriented mathematics classrooms, students are expected to acquire new technical vocabulary, develop comprehension skills, and actively participate in verbal and written mathematical discourse practices (Gee, 1992). To provide an understanding of the nature

of learning and knowing for teachers, this section describes adult learning theories as a framework for understanding adult learning and the difference from younger learners.

Typical adult learning theories encompass the basic concepts of behavioral change and experience (Merriam & Caffarella, 1999). From there, specific theories and concepts diverge based on the theorist. There are conflicting perspectives on adult learning as it relates to and separates itself from early childhood development practices and overall approaches to learning (Merriam & Caffarella, 1999). According to Merriam & Caffarella (1999) all styles of learning are applicable to both early childhood and adult learning, with differences presenting themselves in regard to the use of the style based on the learning environment.

Yang (2004) contends that adult learning theory is a culmination of concepts and theories that demarcate how adults gain knowledge. Furthermore, Yang (2004) illustrates adult learning as a process that adults engage in to establish long-term change in the domains of attitude, knowledge, and behavior. While there are many adult learning theories in the education field, for the purposes of this paper, Knowles' (1984) theory of andragogy will be used as a part of the theoretical framework for the discussion of teacher professional development.

Andragogy consists of learning strategies focused on adults and is often interpreted as the process of engaging adult learns with the structure of the learning experience. Borrowing the term from German educator, Alexander Kapp, Knowles (1984) developed andragogy into a theory of adult education. (Merriam & Caffarella, 1999). Critical to andragogy is the premise that the point at which an individual achieves a self-concept of essential self-direction is the point at which he psychologically becomes

an adult. The five assumptions underlying andragogy describe the adult learner as someone who has an independent self-concept and who can direct his or her own learning; has accumulated a reservoir of life experiences that is a rich resource for learning; has learning needs closely related to changing social roles; is problem-centered and interested in immediate application of knowledge; is motivated to learn by internal rather than external factors (Merriam, 2001).

Knowles (1984) emphasizes that adults are self-directed and expect to take responsibility for decisions; therefore, he postulates that adult learning programs must accommodate this fundamental aspect. In practical terms, andragogy means that instruction for adults needs to focus more on the process and less on the content being taught. Strategies such as case studies, role playing, simulations, and self-evaluation are most useful. In implementing these strategies, instructors adopt a role of facilitator or resource rather than lecturer or grader.

Adult Professional Development

Other researchers have studied the adult learner, each in an attempt to improve the education of these learners. Knowles (1973, 1984) refers to adult professional development as the a critical area that has been neglected and offers five key principles: adults are autonomous and self-directed, adults are goal oriented, adults are relevancy oriented (problem centered)--they need to know why they are learning something, adults are practical and problem-solvers, and adults have accumulated life experiences. Knowles (1990) contends that administrators should consider that teachers should be allowed to plan their own educational paths based on interests, and more importantly, adult education should promote the development of the individual with reflection and inquiry.

Similar to Knowles (1973, 1984, 1990), Oja (1980) studied adult learning as it is applied to teacher professional development and identified four principles for success: supervision and advisement should be continuously available, adults should be encouraged to take on new and complex roles, and feedback and support should be provided to those implementing new techniques. Oja (1980) also found that teachers wanted learning experiences that they could immediately practice in their classrooms. Additionally, Oja (1980) chronicled the teachers' preference for discussion on practices and classroom situation problem solving with their colleagues. Oja (1980) found that teachers' participation in interactive situations about classroom issues facilitated growth and allowed for adults to adapt their lessons based on their learning.

Teacher Preparation

Despite the changing demographics in the student population, most teachers are monolingual, middle class, and have had little or no formal training on how to teach students from diverse backgrounds (Ball, 2008). Part of the explanation for student's low scores on standardized exams is that content teachers in the United States, in general, have not been prepared to provide appropriate instructional programs for English language learners in their classes. "More than 40 percent of all teachers in the nation report that they taught students who are limited in their English proficiency, yet only 12 percent of those teachers had eight or more hours of training in how to teach those students" (Nieto, 2004, p. 219).

Campbell, Adams, & Davis (2007), and Kabasakalian (2007) assert that the lack of teacher preparation on appropriate methodologies for teaching English language learners has been identified as one of the reasons behind the low performance of ELLs on

standardized exams, particularly in mathematics. The National Council of Teachers of English (NCTE) supports the integration of reading and writing in the content area; however, teachers of mathematics often find incorporating reading instruction into their discipline quite problematic. Many mathematics teachers lack the essential training or confidence to teach reading strategies and to integrate literacy instruction into their mathematics classrooms (McIntyre et al., 2010).

The lack of knowledge on how to instruct ELLs does not escape teachers. Many have expressed concern on their inadequate preparation in teaching diverse students and their apprehension in interacting with parents from dissimilar backgrounds (Ball, 2008). The unsatisfactory performance of English language learners on international and U. S. mathematics standardized tests coupled with concerns from national and state curriculum and teacher associations have repositioned discussions on English as a second language (ESL) pedagogy in the mathematics curriculum (Mckinney & Frazier, 2008; Gandara and Contreras, 2009; Garcia, 2010; Draper & Siebert, 2004).

Teacher Knowledge

Given the current emphasis on standards and high-stakes testing in the United States as well as the growing trend to enact laws that mandate the mainstreaming of English language learners after one year of English as a second language (ESL) instruction (Education Commission on the States, 2004; Nieto, 2004), mathematics teachers can no longer wait for ESL students to learn English before they teach them mathematics content.

While the unique contribution of teacher knowledge to student achievement is not new, recent studies have reintroduced its importance (Hill, Blunk, Charalambous, Lewis,

Phelps, Sleep, and Loewenberg Ball, 2008). In their study, Hill, et.al, (2008) found evidence for the proposition that stronger teacher knowledge yields benefits for classroom instruction and student achievement. However, despite the amount of research and current policy initiatives, there is a lack of understanding regarding how teacher knowledge affects classroom instruction and student achievement. While studies in teacher knowledge and mathematics education literatures have raised strong plausible propositions regarding how knowledge matters for teaching, the generalizations have been limited (Hill, et. al, 2008).

Hill et al. (2008) found that studies on teacher knowledge can be generally classified into “deficit” and “affordance” approaches. The “deficit model describes a teacher’s lack of mathematical understanding and patterns in mathematics instruction. In the “affordance” model, the researchers delineate the strong mathematical (and related) understandings that create classroom culture and instruction including the practice of teachers engaged in using new curriculum materials (Lloyd & Wilson, 1998), new forms of teaching (Lampert, 2001), and intensive professional development.

Low mathematics scores on standardized tests for adolescents who speak English as a second language suggest that greater attention to how mathematics content is taught to ELLs is needed (Holmes & Duron, 2000; MacDonald, 2004). This study will add to the growing research base on disciplinary literacy particularly in the mathematics classroom. It will contribute to the research literature on instructional supports for second language acquisition for ELLs.

There are a multitude of theories applicable to adult learning. It is important to distinguish the unique attributes of adult learners so as to be better able to incorporate the

principles of adult learning in the design of instruction. Within the educational environment, adult learning should be aimed at improving individual knowledge and skill, and to improve the organizational performance by applying learning directly to instruction. For the purposes of this paper, adult learning will focus on the professional development middle school mathematics teachers need to meet the needs of their students who are trying to learn mathematical concepts and simultaneously acquire a second language.

Definition of Key Terms

Various terms are used throughout the research study to describe the labels placed on adolescents with limited English proficiency and types of learning. Throughout this paper *English Language Learners (ELLs)* that refers to students whose first language is not English, is used interchangeably with federal legislation terminology, *limited English proficient students (LEP)*. These terms encompass both students who are just beginning to learn English and those who have already developed considerable proficiency and emergent bilinguals.

Highly qualified: a teacher has obtained full State certification as a teacher or passed the State teacher licensing examination, and holds a license in such State (*NCLB*, Title IX, Section 910).

No Child Left Behind: The *No Child Left Behind Act (NCLB)*, signed into U.S. law in 2002, seeks to increase accountability for student performance in public schools. Under *No Child Left Behind*, states are working to close the achievement gap and make sure all students, including those who are disadvantaged, achieve academic proficiency (U.S. Department of Education).

Experienced teacher: (for purposes of this research study), a teacher education program graduate who has completed one to five years of teaching;

Professional development/learning: comprehensive, substantiated and intensive approach to improving teachers' effectiveness in raising student achievement (Mizell (NSDC), 2008).

Learning: (1) deep knowledge of concepts and ideas from important subject matter disciplines, (2) distal measures of learning such as test scores and grades, and (3) increasingly central participation in local communities of practice.

Skillful teaching: a highly variable process that changes depending on any number of contextual factors – whatever helps students learn; adopting a critical reflective stance towards the educational practice; and having a constant awareness of how students are experiencing their learning and perceiving teacher's actions (Brookfield, 2006);

Subject-matter competency: having a knowledge base of understanding for the content area(s) in which a teacher teaches as defined by a professional teaching license;

Texas Assessment of Knowledge and Skills (TAKS): The TAKS are student assessments of the state of Texas' expectations for student learning and achievement at various grades in English, mathematics, science, and social studies (Texas Education Agency, TEA).

Summary

The United States has experienced phenomenal growth in the number of English language learners entering its public schools. These burgeoning numbers pose unique challenges for educators striving to ensure that these students get access to the core curriculum and acquire academic knowledge as well as English-language skills. This chapter presents the propose of the study: to establish which instructional practices and

types of professional development middle school mathematics teachers need to effectively meet the needs of English language learners in the mathematics classroom. Additionally, this study proposes to examine the effects of mathematics teachers' academic background on the academic achievement of second language learners through case studies of three middle school mathematics teachers in a school district in close proximity to the Texas/Mexico border.

Also important to this study are the theories of SLA, sociocultural theories, situated cognition theory, and adult learning theories as lenses for understanding the learning processes in a mathematics classroom. Another dimension important to this study is a synthesis of current research on professional development theories. Chapter 2 provides an extensive review of literature on the theories discussed in this chapter.

Chapter 2: Literature Review

There is no equality of treatment merely by providing students with the same facilities, textbooks, teachers, and curriculum; for students who do not understand English are effectively foreclosed from any meaningful education.

—Lau v. Nichols, 1974

Introduction: Problem

Since its inception, the U.S. public school education system has faced many challenges. One of the biggest challenges has been the education of children from diverse cultures who are not yet proficient in English. Between school year 1997-98 and the 2008-09 school year, the number of English-language learners enrolled in public schools increased from 3.5 million to 5.3 million, or by 51 percent (National Clearinghouse for English Language Acquisition, 2011). During the same period, the general population of students grew by 7.2 percent, to 49.5 million. These burgeoning numbers of English-language learners pose unique challenges for educators striving to ensure that such students get access to the core curriculum in schools and acquire academic knowledge, as well as English-language skills.

A factor in the increasing presence of English Language Learners (ELLs) in U.S. schools is that these students' lack of English language positions them at high risk for academic failure. ELLs, as mandated by No Child Left Behind Act of 2001 (NCLB) must reach high standards and demonstrate proficiency in English language arts and mathematics by 2014. Through these mandates, NCLB (2001) establishes high expectations for all students and seeks to reduce the achievement gap between advantaged and disadvantaged students. While these are worthy goals, they require extraordinary improvement in student learning. The challenges for English language learners are especially difficult, involving both educational and technical issues,

including: (1) historically low ELL performance and slow improvement, (2) measurement accuracy—language demands of tests negatively influence accurate measurement of ELL performance for ELL students as tests measure both achievement *and* language ability. (3) instability of the ELL student subgroup, and (4) factors outside of a school's control (Abedi and Dietel, 2004).

An additional challenge for ELLs documented through research (Freeman & Crawford, 2008), indicates that while the number of ELLs increases, the number of teachers trained in second language acquisition pedagogy declines. Furthermore, little is known on how NCLB (2001) mandates have affected classroom educational practices for students with limited English proficiency. Of particular concern are the pedagogical practices in classrooms where ELLs strive to learn mathematical concepts while simultaneously learning the English language.

Research Questions and Sub Question

In order to provide guidance to the field and address issues specifically targeting English language learners in the mathematics classroom, it will be important to conduct research in this area. The research questions that follow propose to add to the current literature by further exploring the instructional practices of teachers who teach middle school mathematics and their impact on the academic achievement of English language learners.

Research Question 1 What instructional practices do middle school mathematics teachers in this cross case study use in classes with ELLs? Sub-question: How do their different practices result in differential student achievement between mainstream students and ELLs?

Research Question 2 What effect does the academic background and professional development of mathematics teachers in this cross case study have on the academic achievement of their second language learners?

Overview

To understand the reasons for the low performance of English language learners in mathematics, to provide guidance to the field, and to address the aforementioned concerns specifically targeting ELLs in the mathematics classroom, it is necessary to review the research related to the education of English language learners, particularly literature in the secondary mathematics classroom.

In this chapter, I first present an overview of the educational status of second language learners. Then the major theories in second language acquisition including the specialized language of mathematics and the social and cultural phenomenon of language practices and participation in the mathematics communities follow. The next section reviews major findings in disciplinary literacy of mathematics, including student comprehension difficulties in understanding word problems and graphic illustrations and the developmental challenges in the transition between elementary and middle school grades. The following sections review literature on mathematic reforms, the linguistic needs of ELLs in mathematics classes, and the effects of mathematic teachers' quality on English language learners' academic achievement in mathematics. A synthesis of current research on professional development is provided in the concluding section.

Second Language Learners: An Overview

Labels for English language learners

The burgeoning number of English language learners entering public schools poses unique challenges for educators who are striving to ensure language-minority

students reach parity with native speakers on academic achievement. Garcia, Kleifgen, and Falchi (2008) explain that the varied definitions of students who are attempting to acquire the English language has created an additional challenge for this group of students. While the terms “language-minority” and “limited English proficient” are both official designations under federal law, these labels are often problematic. For example, in many communities, “language-minority” students are in the numerical majority. Many of these “bilingual” students are on their way to becoming bilingual, but in the early grades do not understand, speak, read, or write two languages (Vialpando, Yedlin Linse, Harrington, and Cannon, 2005). Garcia et al., (2008) argue that a term such as limited English proficient focuses on the negative, on what students cannot yet do, rather than on their strengths. Even the term second language does not accurately describe a student for whom English is a third or fourth language. Garcia et al, (2008) contend that there is little agreement as to how to label these students. The lack of clear federal standards and definitions adversely affects the ability of students to get the help they need. For example, the fact that there is no standard definition for English language learner means that a student may be considered an English language learner in one district or state but not in another. States or districts may define limited English proficiency according to their capacity to provide services. States or districts may also select different cut scores on the same test of English proficiency to represent the ELL category. As a result, students may not get the help they need when screening procedures are inadequate or inconsistent (National Education Association, 2006).

Educational Achievement

The educational achievement of ELLs as measured by standardized tests is below that of their Anglo counterparts. Nationwide, only 12 percent of students with limited English scored “at or above proficient” in mathematics in the 4th grade on the 2009 National Assessment of Educational Progress (NAEP), compared with 42 percent of students not classified as English-language learners. The gap was considerably wider in 8th-grade math, where 5 percent of ELLs were proficient or above on the 2009 NAEP, compared with 35 percent of non-ELL students.

Spanish speakers constitute a growing number of bilinguals in the United States. By mid-century, Hispanics are projected to represent one-third of all students in U.S. schools and a substantial majority of all students in California and Texas (Garcia, Kleifgen & Flachi, 2008; Garcia, 2010; Gandara & Contreras, 2009). While Hispanic students as a group score well below their counterparts in all content areas, an area of particular concern for future academic and economic success is the mathematics achievement of middle school, low income Hispanic ELLs. Despite the enactment of the No Child Left Behind Act of 2001 (NCLB) legislation, the disparity in the mathematics achievement between low income, middle school students and their affluent peers continues (McKinney and Frazier, 2008). McKinney and Frazier (2008) found disparities in the achievement levels and course enrollments of middle school students based on gender, ethnic groups, learning abilities, and socioeconomic status. Furthermore, McKinney and Frazier (2008) contend that the improvements of mathematics achievement for low-income students have been in basic skills as opposed to contextualized problem solving.

Educational Attainment

As the low NAPE scores indicate, Hispanics have the lowest high school completion rate among the three major subgroups, Hispanics, Anglos, and African Americans. Indeed, when compared to the white dropout rate, the Hispanic dropout rate is nearly three times higher. In 1972, among Hispanics ages 16 to 24, 34.3 percent were high school dropouts (Verdugo, 2005). The comparable rate for whites was 12.3 percent. By 2004, the Hispanic dropout rate had declined to 23.8 percent, while the white rate dropped to 6.8 percent. In 1990, 32.1 percent of the Hispanic population age 25 years or older had completed high school or more. Among the white population age 25 or older, 54.5 percent had completed high school or more. By 2004, 58.5 percent of Hispanics had completed high school, compared to 85.8 percent of whites.

This high dropout rate is partly attributable to the relatively greater dropout rate for Hispanic immigrants at 44 percent, as compared with 21 percent for the U.S.-born students (Garcia, Kleifgen and Flachi, 2008). An important factor in the education attainment Hispanic children is directly related to the parental high school completion as noted by Garcia et al., (2008) and Gandara and Contreras (2009). In their study, Gandara & Contreras (2009) found students from financially poorer families or whose mother had less formal education entered kindergarten with lower levels of mathematics skills and knowledge than their more advantaged peers.

Hispanics also lag behind Whites in college completion. This is a major concern because researchers expect a college degree to be essential for success in an increasingly competitive world. An analysis of college completion indicates that a sizeable percent of Hispanics do not complete their college education. In 1970, 4.5 percent of the Hispanic

population had completed a college degree or more; for whites, it was 11.3 percent. By 2004, 12.1 percent of Hispanics had completed college or more, compared to 28.2 percent of whites (Verdugo, 2005).

The ELL achievement gap widens as the grade levels progress. May (1997), Moje, Young, Readence, & Moore (2000), and O'Brien, Stewart, and Moje (1995) contend that the gap increases at the secondary school level because of teachers' lack of strategies for incorporating literacy into the content areas and related student-centered pedagogical practices and learning-to-learn strategies. According to Moje et al. (2000), teachers who teach ELLs at secondary campuses are generally far less well equipped than their elementary school colleagues. Teachers at middle and high schools are not always versed on addressing the specific literacy demands of their teaching and learning contexts, the related texts and textual practices that they use with their students, and the theories of second language acquisition.

Developmental Challenges in the Transition between Elementary and Middle School

In addition to learning a new language, ELLs must also contend with the transitional challenges that occur when advancing from elementary skills driven lessons to middle school concept based curriculum. Of particular challenge for schools is how to best assist second language learners in meeting proficiency levels on standardized tests and simultaneously learn the English language. The education of ELLs presents a unique set of challenges to educators because of the central role played by academic language proficiency in the acquisition and assessment of content-area knowledge (Fillmore and Snow, 2000). Additionally, ELLs in secondary schools are confronted with the difficulties of advancing from process-oriented, primary classrooms to text-oriented

subject matter learning typical of secondary education (Fillmore and Snow, 2000). This transition constitutes an ongoing academic problem exacerbated by students' lack of domain knowledge and their difficulty in understanding subject-matter vocabulary particularly mathematics academic language.

While reading and writing across the disciplines continue to be essential skills for all students, literacy demands become increasingly complex in middle and high school, and students' ability to think critically to construct meaning is crucial. As they move from class to class, learners contend with new and evolving sets of skills that further define literacy within each subject. Students must think visually, build mental models, and interact with others in order to construct meaning from their dynamic and intricate modern world. While this ability remains the nexus of literacy for adolescents, research has shown that additional abilities are needed to maximize learning in mathematics, science, and social studies disciplines (Meltzer, 2004).

Second Language Acquisition Theory

Significant advances have been made during the latter part of the twentieth century with respect to theories of bilingualism and second language acquisition (SLA). The theories have enhanced understandings about what influences the process of second language acquisition, including the influence of the first language on the second language.

Second language acquisition theory attempts to establish causal relationships between environmental factors and learning. Krashen (1985) is credited with the development of a predominant theory of SLA. Krashen (1985) maintains that adults have two different ways to develop competence in a language: language acquisition and

language learning. An important claim in Krashen's Input Hypothesis (originally referred to as the Monitor Model) and five correlates or sub-hypotheses is the differentiation between acquisition and learning.

The Acquisition/Learning Hypothesis, the distinction between acquisition and learning, is the most fundamental of all the hypotheses in Krashen's (1985) theory. Acquisition, according to Krashen (1985), is a subconscious process that leads to fluency, and learning is a conscious process that shows itself in terms of learning rules and structures and being able to talk about them. Language acquirers are not consciously aware of the grammatical rules of the language, but rather develop a feel for correctness.

Krashen's natural order hypothesis suggests that the acquisition of language, especially the rules of language, follow a predictable natural order. For any given language, some grammatical structures tend to be acquired earlier than others. This idea reflects Chomsky's (1965) notion that we all have a built-in language acquisition device (LAD) that begins to enable us to understand and acquire language within the first year of our lives. Because of the nature of the LAD, for a given language, some grammatical structures tend to be acquired early, others late, regardless of the first language of a speaker.

The Natural Order Hypothesis argues that there is a natural order to the way second language learners acquire their target language. This term emphasizes that the principles behind that approach are believed to conform to the naturalistic principles found in successful second language acquisition. Natural order focuses on exposure to input instead of grammar practice. It is a hypothesis based on research findings of Dulay and Burt (1974) that suggest that the acquisition of grammatical structures follows a

natural order that is predictable. Dulay and Burt's (1974) study examined the order of morphemes acquisition of Chinese and Spanish speaking children and found that the order of acquisition seemed to be independent of the learners' age, first language, and conditions of exposure.

The Monitor Hypothesis explains how the acquired system is affected by the learned system. When second language learners monitor their speech, they are applying their understanding of learned grammar to edit, plan, and initiate their communication. This action can only occur when speakers have ample time to think about the form and structure of their sentences. The amount of monitoring occurs on a continuum. Some language learners over-monitor and some use very little of their learned knowledge and are said to under-monitor. Ideally, speakers strike a balance and monitor at a level where they use their knowledge but are not overly inhibited by it.

The Input Hypothesis seeks to explain how second languages are acquired. The input hypothesis argues that the learner progresses along the natural order only when they encounter second language input that is one step beyond where they are in the natural order. According to this hypothesis, the learner improves and progresses along the natural order when the learner receives second language input that is one step beyond his current stage of linguistic competence. Acquisition will occur if the learner is receiving comprehensible input so that he can build upon his understanding of English based on what he already knows while new information is presented (Krashen, 2003). For example, if a learner is at state i , then acquisition takes place when he is exposed to comprehensible input that belongs to level $i + 1$.

The Affective Filter Hypothesis describes external factors that can act as a filter that impedes acquisition. These factors include motivation, self-confidence, and anxiety. For example, if a learner has very low motivation, very low self-confidence, and a high level of anxiety, the affective filter comes into place and inhibits the learner from acquiring the new language. Students who are motivated, confident, and relaxed about learning the target language have much more success acquiring a second language than those who are trying to learn with the affective filter in place.

Krashen (1985) suggests that a second language is most successfully acquired when the conditions are similar to those present in first language acquisition: that is, when the focus of instruction is on meaning rather than on form; when the language input is at or just above the proficiency of the learner; and when there is sufficient opportunity to engage in meaningful use of that language in a relatively anxiety-free environment. This suggests that the focus of the second language classroom should be on something meaningful, such as academic content. The modification of the target language facilitates language acquisition and makes academic content accessible to second language learners; in other terms, this type of students should received sheltered instruction.

A second theory of SLA, developed by Schumann (1978), asserts that acquiring a new language is part of a more general process of acculturation. He focuses on sociocultural factors that act on the language learner and bases his theory on studies of individuals acquiring a second language with no reference to any internal cognitive processing. Schumann's theory is based on the fact that the greater the social distance between two cultures, the greater the difficulty the learner will have in learning the second language, and conversely, the smaller the social distance, the better the learning

situation will be. For Schumann (1978) there are eight factors that influence social distance: Social dominance is present when language minority group is politically, culturally, technically, or economically superior to the target language group, then it will tend not to learn the target language. Enclosure refers to the degree to which the ELL group and target language (TL) group share the same social constructs such as schools, churches, clubs, recreational facilities, crafts, professions, and trades. If the two groups share these social constructs, enclosure is said to be low, and the second language acquisition is facilitated. Cohesiveness is evident if a language minority group will tend to remain separate from the minority language. Size: If the ELL group is large, the intragroup contact will be more frequent than contact with the TL group. Congruence: If the two cultures are similar, social contact is potentially more likely and L2 learning is more easily facilitated. Attitude: If the ELL and TL groups have positive attitudes toward each other, L2 learning is more easily facilitated. Intended length of residence: The longer an L2 learner plans to remain in the TL environment, the more likely it is that they will feel the need to learn the target language. Assimilation, preservation, and adaptation: If the ELL group chooses assimilation as the integration strategy, it gives up its own lifestyle and values and adopts those of the TL group. Similarly, preservation means that the ELL group maintains its own lifestyle and values and rejects those of the TL group. Adaptation means that the ELL group adapts to the lifestyle and values of the TL group, but maintains its own lifestyle and values for intragroup use.

In addition to social distance, Schumann (1978) introduces a second factor that can be used to predict the degree of language acquisition: psychological distance. He identifies four main characteristics that determine the psychological distance a second

learner has from the target language and culture: language shock, the extent to which second language learners fear they will look comic in speaking the second language; culture shock, the extent to which second language learners feel anxious and disorientated upon entering a new culture; motivation, the extent to which the second language learner are instrumentally motivated to learn the second language; and ego permeability, the extent to which second language learners perceive their first language to have fixed and rigid or permeable and flexible boundaries and therefore the extent to which they are inhibited.

Krashen (1985) and Schumann (1978) are credited with the development of two of the most influential second language acquisition theories. Krashen's theories of SLA suggest that language acquisition is innately determined and that humans are born with a built-in language acquisition device (LAD) that results in a natural order of language acquisition, the natural order, which predisposes us to acquire language. The LAD first proposed by Chomsky (1965) is a concept of an instinctive mental capacity that enables an infant to acquire and produce language. As a component of the nativist theory of language, this theory asserts that humans are born with the instinct or "innate facility" for acquiring language. However, Chomsky gradually abandoned the LAD in favor of a parameter-setting model of language acquisition principles and parameters.

The LAD is interrelated with universal grammar (UG). Grammatical acquisition proceeds on the basis of a partial genotypic specification of (universal) grammar (UG) complemented with a learning procedure enabling the learner to complete this specification appropriately (Briscoe, 2000). The parameter setting framework of Chomsky (1981) claims that learning involves fixing the values of a finite set of finite-

valued parameters to select a single fully-specified grammar from within the space defined by the genotypic specification of UG. (Clark, 1992; Gibson and Wexler, 1994; Niyogi and Berwick, 1995).

Krashen (1985) maintains that language learning is a subconscious and natural process during which the learner improves with real-life practice while Schumann's (1978) acculturation model places emphasis on integrating the language learner with target language culture and community. Furthermore, the acculturation theory (Schumann, 1978) centers on the impacts of extrinsic variables on language learning, such as social, economic, political, psychological, technological, religious elements, and so on.

Social and Academic Language

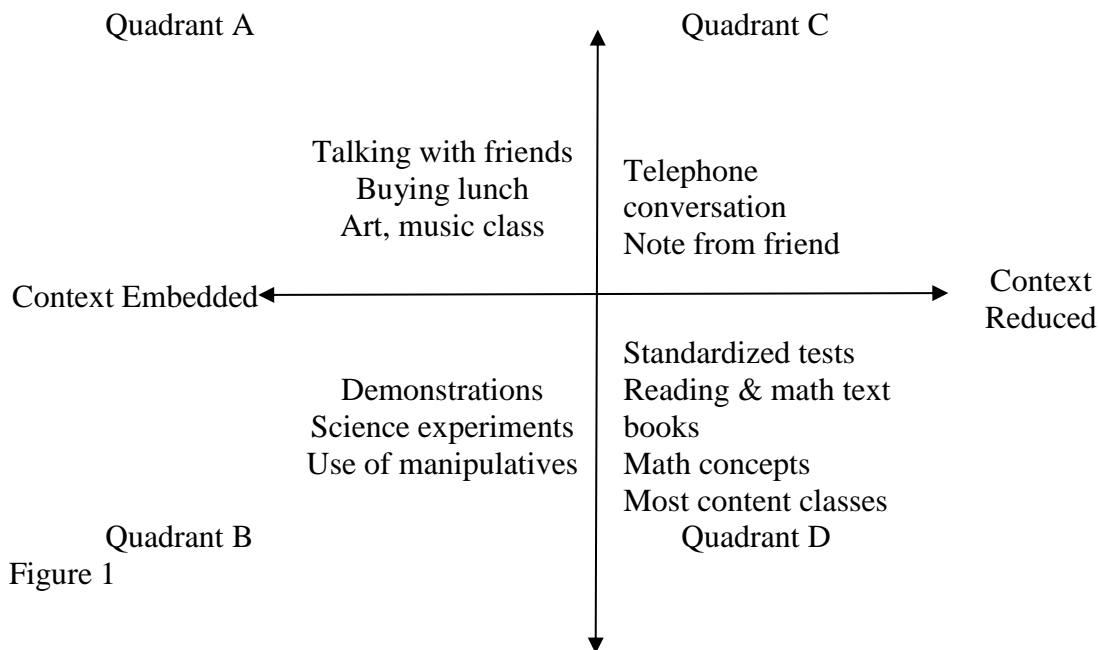
While Krashen and Schuman developed theories of a general language acquisition, Cummins' (1980) proposed that there are two different types of language proficiency that individuals develop: conversational fluency and academic language proficiency. Cummins' claims have led to changes in the instructional practice in bilingual and ESL classrooms. Conversational fluency refers to daily conversational face interactions where meaning is supported by contextual cues in a meaningful social setting. Within this setting, language is context embedded. With academic language proficiency, the student demonstrates the ability to make complex meanings in a cognitively challenging, context reduced setting. Cummins (2003) postulates that once a student has acquired academic language, he is equipped to understand and communicate in the academic disciplines.

According to Cummins (2003), social language is used in everyday, face-to-face interactions. While this is the speech most used during recess, in the hallway, and outside the school, it is also much needed in the classroom. Academic language, on the other hand, is used to acquire new knowledge or skills, develop deeper understanding of a topic, and communicate that understanding to others; it is the language students must use to effectively participate in content-rich discourse. Academic language refers to the vocabulary syntax, and other language forms necessary to participate in classroom lessons and various other types of academic interactions. Compared to conversational language, academic language tends to be more abstract and cognitively demanding, and makes more assumptions about what speakers and listeners already know (Freeman and Freeman, 2009). Obviously, distinctions between social and academic language are not precise, as classroom discourse and subject area discourse often make use of both.

Cummins (2003) stated that failure to take into account the distinction between conversational and academic fluency has led to some students' premature exit from language support programs and to an overrepresentation of ELLs in special education programs. This distinction between conversational fluency and academic language proficiency was supported by Cummins' (1980, 1981) two research studies. One study was a reanalysis of data from the Toronto Board of Education. Despite teacher observation that peer-appropriate conversational fluency in English developed rapidly, a period of 5-7 years was required, on average, for immigrant students to approach grade norms in academic aspects of English because of the higher level of English proficiency required to read and write in a more cognitively, challenging and decontextualized academic setting (Cummins, 2003). In a second study, Cummins (1980) analyzed the

psychological assessments of over 400 immigrant students. Cummins presented data which showed that immigrant children require, on the average, at least five years of instruction in the second language to approach native conceptual and literacy skills. The study revealed the limitations of psychological assessment instruments and their incorrect diagnoses of immigrant students' academic difficulties. The study also highlighted the failure of psychologists to take account of the second language development process ultimately making inappropriate academic placements.

Cummins represented his theory through a Quadrants model. This model provides a means of describing the linguistic and cognitive demands experienced by ELLs. In the quadrant model, language tasks range in difficulty along two continua, one from cognitively undemanding to cognitively demanding and the other from context-embedded to context-reduced. The horizontal line is labeled context embedded moving towards context-reduced tasks as demonstrated in *Figure 1*.



The vertical line is labeled cognitively undemanding moving towards cognitively demanding tasks. The goal is to move the student through all the quadrants beginning with quadrant A, where the students have conversational skills but still need context clues to comprehend well, to quadrant D where students will have success with cognitively demanding tasks without context clues.

Research shows that it takes approximately two years for second language learners to approach a native speaker's level in conversational fluency and from 5 to 7 years for them to approach a native speaker's level in academic language proficiency (Collier, 1987; Cummins, 1981, 2003). A review of research conducted by Hakuta, Butler, & Witt (2000) further reveals that it may take from 3 to 5 years for English language learners to acquire oral proficiency and from 4 to 7 years to acquire academic English proficiency.

Academic Language of Mathematics

The integration of literacy and math content instruction is a relatively new and challenging concept for many teachers (Moschkovich, 2002; Robertson, 2009). Several barriers impede the effort to build effective literacy support into the daily mathematic experience of adolescent learners. These barriers relate to a complex array of factors: students' and educators' belief systems, inadequate professional development, organizational and structural impediments, lack of understanding about what needs to be done, lack of focus, and unwillingness to make the changes necessary to support adolescent literacy development (Draper and Siebert, 2004; Moje, 2008). Furthermore, many secondary educators view literacy instruction as an elementary school responsibility, believing that secondary school teachers should focus only on teaching

content (Draper and Siebert, 2004; Meltzer and Hamonn, 2004; Moschkovich, 1999; Nasir, Hand and Taylor, 2008). At the secondary school level, reading comprehension skills must become increasingly sophisticated to address the demands posed by more challenging academic expectations, as well as the literacy demands according to the discipline or content area. Academic language can be broken down into the registers of the different content areas. The academic language of mathematics has its own special vocabulary, syntax (sentence structure), semantic properties (truth conditions), and discourse (text) features. Unlike natural language, however, math texts: (a) lack redundancy and paraphrase, (b) are conceptually packed, (c) are of high density, (d) require up-and-down and left-to right eye movements, (e) require a slower reading rate than natural language texts, (f) require multiple readings, (g) are made up of a variety of symbols such as charts and graphs, and (h) contain a great deal of technical language with precise meanings (Moschkovic, 2001, 2002). For ELLs learning the English language and the academic language of mathematics is double the work. So, for teachers to assist ELLs in simultaneously learning the English language and mastering the mathematics academics, teachers must be cognizant of what ELLs need to learn the academic language of the content area.

The prevailing view in mathematics education is that mathematics is a universal language that requires the ability to master a well-defined body of knowledge, often through repetitive practice and the ability to process abstract information (Freeman and Crawford, 2008; Moschkovich, 1999, 2002). Because of the universality of mathematics, little attention is placed on the students' cultural or linguistic backgrounds (Freeman and Crawford, 2008; Moschkovich, 2002). However, literature on effective

schooling for bilingual students suggest that language and culture play important roles in learning and therefore have significant consequences for effective teaching (Brown, Collins, and Duguid, 1989; Moschkovich, 2002, 2007; Nasir, Hand and Taylor, 2008;).

The issues involved in teaching English language learners mathematic content while they are learning English present many challenges for mathematics teachers and highlight the need to focus on language-processing issues related to teaching mathematical content. Corson (1997) and Freeman and Freeman (2009) concur that students should be provided ample opportunities to learn the academic language; however, the approach, particularly for ELLs, should be context embedded and comprehensible. Yet, teaching academic language, particularly in mathematics, is quite challenging because of the mathematics register. The linguistic term register refers to the particular kind of language used in a specific situational context. Halliday (1978) uses the term to describe “a set of meanings that is appropriate to a particular function of language, together with the words and structures which express these meanings” (p.195). The mathematics register is made up of specific uses of language for mathematical purposes. This includes the words and structures of mathematics, both spoken and written, and the meanings they express. In the mathematics classroom there is an implicit requirement to use language in certain kinds of ways. Teachers introduce and model 'mathematical' words and language structures which are privileged over other language forms. Learning mathematics involves learning its register and the language variety “used in a certain context of the situation” (Freeman and Freeman, 2009). Because of this, Moschkowitz (2000) points out that ELLs not only translate between English and their home language, but between both sets of social and academic languages. Thus,

mathematics teachers who value communication in the classroom must consider an ELL's ability to participate in both "everyday" and "mathematical" kinds of interactions.

Researchers have also emphasized the considerable variation in the formal and functional characteristics of language from one academic subject to another (Bailey, 2007; Schleppegrell, 2004). Bailey (2007) maintains that the language skills necessary for students to function effectively in mathematics are quite distinct from the language skills needed for social studies, although clearly there is some overlap. Differences include specialized vocabulary, grammatical, discourse, and pragmatic skills that are essential for mastery and participation in communities of mathematical discourse as required by The National Council of Teachers of Mathematics (2000) Standards (Schleppegrell, 2004).

Fang and Schleppegrell (2010) contend that mathematical texts draw on two different languages—natural language and mathematics symbolic language. In addition to the language, students must also grapple with the visual representation through graphs, diagrams, and other visual elements. Additionally, word problems as argued by Fang and Schleppegrell (2010), “do not fully illustrate the challenge of reading mathematics” (p. 53), instead word problems represent high stakes context which require students to demonstrate knowledge. Teachers then must learn strategies to help students “unpack” the dense clauses typically found in mathematics content.

Most studies of language difficulties in mathematics depict the kinds of vocabulary that ELLs have trouble with, what sentence structures cause problems, how the correspondence or noncorrespondence of words and symbols affect math learning, characteristics of word problems that make their comprehension difficult, and so forth.

Some of the semantics difficulties are found in words with math meanings that are different from everyday meanings: *set, point, field, column, sum, random, table, altogether, round, and equals*. Of particular difficulty are the conceptually dense expressions that convey very complex meanings: *exponent, coefficient* or combining two or more concepts to form a new concept: *common denominator, least common multiple*. Also problematic for English language learners are multiple terms with the same meaning: *add, sum, plus, combine, put together*, etc. Additionally, second language learners must recognize syntactic differences between the relationship of two words such as the groups listed: *all numbers, greater/less than x, twenty is five times x*, and *when 10 is added to x* (Irujo, 2009; Moschkovich, 2002, 2005; Nasir, Hand and Taylor, 2008;).

Robertson (2009) posits that word problems “require that students read and comprehend the text of the problem, identify the question that needs to be answered, and finally create and solve a numerical equation” (p. 2). Math problems repackage much information in a few sentences. To un-pack mathematical problems, students have to recognize the language features that indicate what the mathematical text is asking them to do. Furthermore, students must have a strong knowledge of how multisyllabic vocabulary words, and common multiple-meaning words, passive verb constructions, and the connecting words that indicate relationships between parts of a sentence work to create the math problem (Corson, 1997). Unlike other texts, each word and symbol in mathematical texts must be read and understood with precision. Moschkovich (2002) contends that the difficulty of mathematics lies in the multiple meanings of common English words. The authors refer to this difficulty as “overlap” found in the multiple meanings of terms such as *plane, difference, odd, or radical*.

Wong-Fillmore and Snow (2000) list a series of words that pose many challenges for ELLs, terms that express various kinds of quantitative relationships as well as everyday words that provide logical links in sentences typical to mathematical word problems. Moschkovich (2002) argues that multi-meaning words are important for math, but cautions teachers to be careful not to interpret the notion of register as a list of technical words and phrases. Centering on multiple meaning words only may disregard the role of meaning in learning to communicate in mathematical discourses.

Acquiring vocabulary and constructing multiple meaning perspectives can have an important impact on instruction. TESOL's revised 2006 PreK-12 English Language Proficiency Standards offers a conceptual framework for standards-based, classroom instruction and assessment. Standard 3 specifically addresses ELLs in the mathematics classes: "English language learners communicate information, ideas, and concepts necessary for academic success in the area of mathematics (TESOL). These new standards call for using students' first languages and cultures as the foundation for developing academic language proficiency. Additionally, they provide an organizational structure that is synchronized with federal legislation.

It is important to note that TESOL's 2005 language proficiency standards have been redesigned to meet the mandates of the NCLB (2001) and the needs of ever-increasing numbers of English language learners in U.S. schools. Additionally, the revised standards reflect the growing body of literature and methodologies that focus on language proficiency within the academic demands of the classroom. Of particular importance to the mathematics classroom is the developmental stages of language acquisition outline that include the language associated with rich academic content. These

standards align with academic content standards to offer opportunities for continuity of learning, bridge the language associated with core content areas to skills and knowledge of that content, and are a starting-point for fair and equitable education of students acquiring an additional language.

To compound matters, language patterns in mathematics are distinct from other content areas. Word problems contain long complex noun groups, are multisemiotic and often polysemous (Fang and Schleppegrell, 2010). Additionally, the text of word problems is generally presented in two distinct parts. The first part is the contextualized situation that students can relate to; the second section, the mathematical equation must be abstracted from the situation. To solve math word problems, students must be able to differentiate between experiential meaning (what the text is about), interpersonal meaning (the interaction, interpretation, attitudes and judgments embedded in a text) and the textual meaning (how a text is organized as a coherent message) Moschkovich (2002).

In addition to becoming cognizant of the negotiation process for learning, English language learners must learn the ways of using the language of math for academic purposes. Mathematics is a language of words, numerals, and symbols that are at times interrelated and interdependent and at other times disjointed. Wakefield (2000) presents eleven characteristics of mathematics that qualify it as a language: 1) math language has many abstractions and verbal or written symbols representations; 2) ideas or images are used to communicate; 3) symbols and rules are uniform and consistent; 4) expressions are linear and serial; 5) understanding increases with practice; 6) success requires memorization of symbols and rules; 7) translations and interpretations are required for

novice learners; 8) meaning is influenced by symbol order; 9) communication requires encoding and decoding; intuition, insightfulness, and “speaking without thinking; accompany fluency; 10) experiences from childhood supply the foundation for future development; and 11) the possibilities for expressions are infinite (pp. 272–273). Dale and Cuevas (1992) and Jarret (1999) also contend that mathematical reasoning and problem solving are closely linked to language and rely upon a firm understanding of basic math vocabulary. Palumbo and Sanacore (2009) add that mathematical vocabulary knowledge facilitates learning mathematical concepts; nevertheless, teachers are confronted with teaching difficult concepts to students who lack proficiency in the language. Traditionally, mathematics has been thought of as an area with minimal language demands. In fact, mathematics and language are intricately connected—language facilitates mathematical thinking (Dale & Cuevas, 1992). Today’s emphasis on problem solving and communication in mathematics means, more than ever, that students must be skilled in using at least the basic language of mathematics

Social and Cultural Issues of Mathematics Language

To learn math includes learning the language of math and understanding knowledge as a cultural activity. Central to the view of knowledge as a cultural activity is Vygotsky’s (1962) premise that mental functioning is part of and flows through our activities in the social world. Additionally, Vygotsky (1962) contended that knowledge is necessarily mediated by tools and signs that we construct and adapt as we coordinate activities with each other to solve problems and achieve our goals. Nasir, Hand and Taylor (2008) add that we develop goals by assessing what we have the potential to do within a particular context.

Recent research in the area of situated cognition has led us to understand that knowledge is situated within socially organized systems of activity embodied as individuals project and manage themselves and their goals within these systems (Nasir, Hand and Taylor, 2008; Brown, Collins and Duguid, 1989). Situated cognition theory refers to learning that occurs in a particular context and culture related to the presented activity (Brown, Collins and Duguid, 1989). Gee (1992) argues that the concept development is dynamic, interactive, and socioculturally situated. Coming to understand what roles we take and discerning what patterns of activity are available are important as we move through various discourse communities. This concept is important for all learners, but is crucial for second language learners if they are to become part of a mathematic community. Additionally, students must take their role as learners to be purposeful, integral and, active to become more engaged in knowledge-building activities (Nasir, Hand and Taylor, 2008).

Another area for consideration is how students coming from another country have been taught mathematics. It is important to note that schooled students arriving from Mexico have more than likely been taught mathematics academic terms in Spanish. Research shows that second language users of English who have attended school regularly, enroll in U. S. schools with a high level of proficiency in math and science, but begin to drop in math scores once they are taught in English. This aspect points to second language teaching and learning as the inhibitor of their progress. Often mathematics teachers do not have a command of Spanish mathematics academic language needed to explain concepts thoroughly. In essence they do not have access to the Spanish mathematics register. Because of their lack of the Spanish academic language, they may

end up using direct translations that may be incorrect, end up speaking in incomplete sentences and do not teach mathematics by way of explanations, questions and cues (Secada, Fennema, and Byrd, 1995).

Social and Cultural Phenomenon of Language Practices and Participation in Mathematics Communities

A situated-sociocultural view of mathematics cognition, language, and bilingual learners has important implications for instruction. Brown, Collins and Duguid (1989) emphasize the idea of cognitive apprenticeship: “Cognitive apprenticeship supports learning in a domain by enabling students to acquire, develop and use cognitive tools in authentic domain activity. Learning both outside and inside school, advances through collaborative social interaction and social construction of knowledge” (p.39). The concept of cognitive apprenticeship is also credited to the works of Lave and Wenger (1991) as well as Wenger (2005).

Unlike the perspectives of vocabulary and multi-meaning words, viewing mathematical learning through the sociocultural and situated cognitive theory lens presents an opportunity for teachers to help students use resources from registers and language to communicate mathematically rather than placing emphasis on deficits. This perspective is not only grounded on both the works of Brown, Collins, and Duguid (1989) it is also positioned in the notion of Discourses as defined by Gee (1996). According to Moschkovich (2002), Gee (1996) considers learning as an inherently social and cultural activity and builds on students’ previous work on classroom mathematical discourse. Learning is then viewed as a discursive activity and participation in a community of practice.

Academic language is embedded in a predictable social context, so to characterize

academic language necessitates examining what students need to do with language to achieve a range of goals in the classroom. The most direct way to describe the language associated with these academic goals is to analyze the tasks and activities that students are expected to participate in and the associated language students need to complete the tasks. This approach leads to a focus on language functions. The term *language function* is used here to refer to the language students must understand and use to complete educational tasks (Halliday and Hassan, 1989 Fang and Scheleppegrell, 2010). The use of the term *function* is complicated by interdisciplinary differences in definition and application, as well as the ongoing tension between language and cognition. Bailey and Butler (2002), in presenting the evidenced-based research framework for operationalizing academic language state, “While the focus of this research is specifically on language, language is used for a purpose often to achieve a function, to explain, to interpret, etc., and thus is interwoven with cognition such that it is nearly impossible to exclude one from consideration of the other” (p.55). Mathematical operations can be signaled in many different ways, posing additional challenges for language-minority students. For example, addition can be signaled with the words: add, plus, combine, and, sum, increased by. Language-minority students may attempt to read and write mathematical sentences in the same way that they read and write standard narrative text. In other words, they may try to translate word-for-word between a mathematical concept expressed in words and the concept expressed in symbols. However, the way a mathematical concept is expressed in words often differs in its order from the way the concept is expressed in symbols. A linear, one-to-one translation is often not possible. Dale and Cuevas (1992) offer as examples the phrase eight divided by two, which might be incorrectly translated to $8/2$

rather than $2/8$, or the algebraic phrase, the number a is five less than the number b , which the student may mistakenly restate as $a=5-b$, when it should be $a=b-5$. Students who are learning English as a new language often have difficulty interpreting the meaning of logical connectors in mathematics and science discourse. Logical connectors are words or phrases, such as: *if, because, however, and consequently*, that signal a logical relationship between parts of a text. In mathematics, logical connectors signal similarity or contradiction; cause and effect; reason and result; and chronological or logical sequence. Students who have trouble with logical connectors in a mathematical problem may be able to solve it when it is restated using a declarative sentence (Dale & Cuevas, 1992). Changes in the understanding of second language acquisition and the need for academic language have led to changes in second language acquisition instruction.

Educational research in the past 15 years, according to Ball, Lubienski, and Mewborn, (2001) focused overwhelmingly on teachers' knowledge and beliefs but only a small number of these studies explored how mathematics teachers' knowledge affected their practice, and even fewer investigated how this knowledge or lack of it affected students' learning. Some articles in the field of math address the topic of preparing future teachers to work with culturally diverse students (Secada, Fennema, and Adajian, 1995; Rodriguez and Kitchen, 2005), in mathematics and science classrooms. The articles cover issues such as the importance of teacher belief in student achievement, the value of making connections between students' home cultures and course content, and the long-term nature of teacher development; however, the studies do not, at least in their discussion of math teachers, focus specifically on the challenges of working with ELLs.

The Evolution of Second Language Instruction

Throughout the history of the nation, the United States has gone through periods of high and low tolerance of bilingual education programs. From the first non-English speaking settlers of the United States to an age where post-September eleventh nationalists' attitudes appear to be legislating bilingual education policy, the historical events of this country have been fundamental factors in determining the policies and legislation surrounding bilingual education. Title III of the No Child Left Behind (NCLB) Act, 2001 requires that all English language learners (ELLs) receive quality instruction for learning both English and grade-level academic content. NCLB allows local flexibility for choosing programs of instruction, while demanding greater accountability for ELLs' English language and academic progress. Under Title III, states are required to develop standards for English Language Proficiency and to link those standards to the state's Academic Content Standards. Schools must make sure that ELLs are part of their state's accountability system and that ELLs' academic progress is monitored over time.

Changes in the prevailing political climate coupled with immigration patterns have historically led to the expansion or diminishment of bilingual education in the United States. Currently school districts provide several programs to assist students in obtaining proficiency in the English language. Garcia et al, (2008) cite six main educational programs for English language learners. These programs range from exposure to the English language to those designed to help ELLs gain proficiency while supporting academic development in their primary language.

ESL programs are implemented in public schools where students who are limited English proficient (LEP) attend. *ESL* programs have been required since the Elementary

and Secondary Education Act was passed in 1965. In 2001, the No Child Left Behind Act made these requirements more specific. The main purpose of ESL programs is to teach the English language to students who do not speak English as their first language so that they may attain educational achievement. The program is designed to prepare students in the language skills necessary for successful academic work. In some instances these classes accommodate students from different language backgrounds in the same class, and teachers do not need to be proficient in the home language of their students. *ESL pull-out* is generally used in elementary school settings. In this program, students spend part of the school day in a mainstream classroom, but are pulled out for a portion of each day to receive instruction in English as a second language. *ESL class period* is generally implemented in middle and high school settings. Students receive *ESL* instruction during a regular class period and usually receive course credit. Students in this situation may be grouped for instruction according to their level of English proficiency. Collier and Thomas (2002) define push-in programs also known as alternative teaching as classroom situations when the ESL teacher either works at a separate table with individuals or a small group of ESL students or when the teacher pushes them in (stays at a table or corner of the classroom) to work on a specific concept being taught in the mainstream class. This could be used for pre-teaching and/or reviewing in particular.

Bilingual programs are generally either *early-exit* or *late exit*. *Early-exit* programs are designed to help children acquire the English skills required to succeed in an English-only mainstream classroom. These programs provide some initial instruction in the students' first language, primarily for the introduction of reading, but also for clarification. Instruction in the first language is phased out rapidly, with most students

mainstreamed by the end of first or second grade. *Late-exit programs* differ primarily in the amount and duration that English is used for instruction as well as the length of time students participate in each program. Students remain in late-exit programs throughout elementary school and continue to receive 40% or more of their instruction in their first language, even after they have been reclassified as fluent-English-proficient.

Freeman, Freeman & Mercuri (2006) delineate the four main types of dual language programs, which mainly differ in the population and the percentage of time allocated to each language. The first labeled developmental, or maintenance, bilingual programs enroll primarily students who are first language native speakers. The Two-way (bilingual) immersion programs also known as TWI enroll a balance of native English speakers and native speakers of the first language. The third type, the foreign language immersion, language immersion, or one-way immersion programs enroll mainly native English speakers. The fourth is the heritage language programs that mostly enroll students who are dominant in English but whose parents, grandparents, or other ancestors spoke the first language.

While the bilingual and ESL programs provide students important support for four years, Collier and Thomas (2004) have deemed them as remedial classes because they do not fully close the gap between English language learners and their English speaking counterparts. Furthermore, Collier and Thomas (2004) argue that these types of classes isolate students from the mainstream curriculum with “watered down” instruction, so students lose instructional ground to those in mainstream classrooms. Thomas and Collier (2004) found that dual language enrichment models of schooling enhanced student outcomes fully closing the achievement gap in second language.

Thomas and Collier's (2004) research serves as a framework for effective language education programs. For mathematics teachers to assist their English language learners to learn mathematics concepts and the English language, Thomas and Collier (2004) recommend they focus on a core academic curriculum; separate the two languages for instruction; use the non-English language for at least 50 percent of the instructional time; promote positive interdependence among peers and between teachers and students; develop active parent-school partnerships. Thomas and Collier (2004) also recommend that teachers be proficient in the language of instruction. While these recommendations should be enacted, currently there are few bilingual programs in secondary schools. As a result, secondary teachers of mathematics have to depend on the use of English as a Second Language (ESL) methods for teaching mathematics to second language learners.

Methods of Second Language Instruction

According to Krashen (1985) the goal of a bilingual program is to mainstream the student gradually, but since some instruction occurs in the primary language, bilingualism is also possible. In some school situations, especially at the secondary level, the primary language instruction component is not feasible (unless the instructor is bilingual or has native-speaking aides to assist LEP students with individual instruction) because either a variety of native languages are spoken by the students or the number of speakers of any given language is small.

Many researchers maintain that the best way to help English language learners is to provide better classroom instruction that focuses on effective, research-based instructional practices developed specifically for ELLs. Various programs have evolved in the efforts to meet the educational needs of ELLs. Whatever the context, teachers will

enter the classroom with a set of assumptions, or an orientation, about teaching and learning generally and about teaching and learning languages specifically. The different orientations include grammar-based orientation, grammar-translation method, communicative orientation, direct method, audiolingual method, notional-functional approach, Suggestopedia, the Silent Way, and Total Physical Response (Freeman and Freeman, 1989).

The Grammar-Based Orientation is founded on the belief that learning a language means learning the grammar and the vocabulary. This study is intended to expand the intellect. For example, students don't expect to communicate in Latin or Greek, but studying those languages is thought to be good mental discipline. The goal is to be able to translate great works from the classical languages into English (Freeman and Freeman, 1989).

The Grammar-Translation method is most commonly used with the grammar-based orientation. This approach also has students study grammar and vocabulary. The focus is on developing the ability to translate between English and the primary language. This approach is not widely used in ESL settings, but is used in EFL settings.

The second early orientation to learning a second language is the Communication Orientation dating back to the 1800s and based on the work of Gouin who observed children learning language in a natural environment. In classes using this orientation, the teacher and students speak only in the target language in order for students to learn to communicate in the language they are studying. The goal is for students to associate words in the new language with their meanings instead of translating terms into their native language. Emphasis is placed on oral language but students are also given

exercises that involve written language. Readings and discussion often center on the popular culture of the countries where the target language is spoken.

The Direct Method dates back to 1884 and is tied to German scholar and psychologist, F. Franke who provided a theoretical justification for a monolingual approach to teaching. According to Franke, a language can best be taught by using it actively in the classroom. Rather than using analytical procedures that focus on explanation of grammar rules in classroom teaching, teachers encourage and direct the spontaneous use of the foreign language in the classroom. A goal of this method is to get students to think in the target language. Teachers create situations in which students can communicate for real purposes. Students are evaluated through actual use of the target language with activities such as oral interviews and assigned written paragraphs.

In the audio-lingual method (ALM) students are asked to repeat a word or phrase that the teacher has said. Students are praised for correctly mimicking the phrase or asked to repeat the phrase until it is said correctly. Although aspects of this method, such as drills in the beginning stages of language learning, continue to be used, most language educators now realize that language is more complex than mere mimicking.

The Notional-Functional Approach is the name given to teaching methods that focus on notions such as time, place, cost, person, quantity, emotional attitudes, beliefs; and functions such as asking, questioning, enquiring, describing, applauding, criticizing, requesting, explaining, etc. This approach is common in basic conversational language courses and publications where everyday, notional words and functional sentences are used, for example *What time is it? Is this the train to San Antonio? My name is María.* This thematic approach, like the Situational Approach, is incorporated by most other

teaching methods to different degrees.

Suggestopedia is a teaching method developed by Bulgarian educator, Georgi Lozanov. It is based on the idea that people, as they get older, inhibit their learning to conform to the social norms and in order to reactivate the capabilities they used as children. The term Suggestopedia, derived from suggestion and pedagogy, is often used loosely to refer to similar accelerated learning approaches. The suggestopedic approach is said to increase the ability of students to learn, to remember, and to integrate what they learn into their personality. The goal is to eliminate stressful situations in learning a language. Teachers begin with speaking in student's first language and use music, role playing, games and skits—using many modalities.

The dual objectives of Communicative Language Teaching (CLT) are to provide learners with language that is appropriate to their communicative needs in particular situations, as well as strategies that enhance their language skills. In this method, teachers serve as counselors who facilitate learning and create a learning community with students. The goals of CLT are to lower students' defenses and to encourage open communication. In part, like the Notional-Functional Approach, CLT focuses on language functions: asking, agreeing, inviting, criticizing, apologizing, suggesting, etc. rather than on grammar and vocabulary. This approach maintains that if learners have enough exposure to the language and the opportunity to use it, then language learning becomes almost automatic and natural. CLT activities involve real-life situations, role-play and simulation, and places more emphasis on the completion of the communication task rather than on the accuracy of the language forms used.

The Natural Approach method places emphasis on making oral input

understandable in a natural way with emphasis on free voluntary reading and student motivation. Teachers' main goal is to make instruction comprehensible. In this method, students move through 4 stages: preproduction, early production, speech emergence, and intermediate fluency.

The Silent Way is the name of a method of language teaching devised by Caleb Gattegno. This method is based on the premise that the teacher is silent most of the time, uses manipulatives with little modeling in a complex approach, and encourages the learner to produce as much language as possible. In the Silent Way, learning is facilitated as the learner discovers or creates rather than remembers and repeats what is to be learned.

The Total Physical Response (TPR) method of teaching language is using physical movement to react to verbal input in order to reduce student inhibitions and lower their affective filter. It allows students to react to language without thinking too much, facilitates long-term retention, and reduces student anxiety and stress. In order to implement TPR effectively, teachers must plan regular sessions that progress in a logical order, and to keep several principles in mind. In TPR, the teacher introduces the language through the use of commands and has students demonstrate their understanding through action responses.

Different methods have been used to teach ESL in both ESL and bilingual programs. Content based ESL has been discussed by ESL professionals since the 1980s (Chamot & O'Malley, 1986; Cuevas, 1984). Early methods focused on the development of conversational English. Students spent hours in language booths listening to, and repeating, the vowels and consonants of English. Later patterns were added, and

eventually, practice in intonation patterns. Content-area teachers have looked to sheltered English instruction as a way to make content comprehensible for ELLs in their classrooms. When first used in connection with ELLs, the term defined students as sheltered because they studied in classes disconnected from mainstream students and sheltered students were not required to compete academically with native English speaking students (Freeman & Freeman, 1988).

Sheltered English

One type of instruction that offers promise in helping LEP students develop academic competence while also developing English proficiency is sheltered English. Sheltered Instruction, referred to in some areas of the U.S. as *Specially Designed Academic Instruction in English* (SDAIE) is a teaching approach founded on the concept of providing meaningful instruction in the content areas (social studies, math, science) for Limited English Proficient (LEP) students in content area classrooms while they reach English fluency. LEP students in content area classes have transitioned to the intermediate and advanced levels of English proficiency.

Since the early 1980's content-area teachers have looked to sheltered English instruction as a way to make content comprehensible for the ELLs in their classrooms. In the days when the term was first used in connection with ELLs, students were considered “sheltered” because they studied in classes separate from “the mainstream” and did not compete academically with native English speaking students (Freeman & Freeman, 1988). Today, the majority of second language learners study alongside their English-speaking peers, are held accountable to the same curriculum standards, and take the same high-stakes tests.

Content-based ESL is a method that integrates ESL instruction with subject matter instruction. The technique focuses not only on learning a second language, but using that language as a medium to learn mathematics, science, social studies, or other academic subjects. Content-based ESL programs at the elementary and secondary school levels became popular within the last several decades. In CBI, grammar is taught, but it steps aside from being the center of attention, while content and learning strategies take the limelight, starting with work in math and science and moving in succession to language arts and then social sciences. One of the reasons for the increasing interest among educators in developing content-based language instruction may be the theory that language acquisition is based on input that is meaningful and understandable to the learner (Krashen, 1981, 1982).

Instead of providing watered down curriculum for LEP student, sheltered instruction allows for the content to be equal to that of native English speakers while improving their grasp of the language. This type of instruction extends the time that students participate in instruction that explicitly provides language support as well as standards-based content instruction. Sheltered instruction also teaches ELLs how to perform academic tasks and focuses on building knowledge of academic language, content, and performance to help prepare English language learners for classes in which they are expected to achieve high academic standards alongside their English-speaking peers. In the sheltered English classroom, teachers use physical activities, visual aids, and the environment to teach academic language necessary for concept development in content areas (National Clearinghouse on Bilingual Education, 1987). At secondary campuses students tend to receive sheltered instruction by content area teachers.

When the language of instruction is English, the learning of mathematics by students whom English is a second language raises some important issues for instruction. The complexity of the processes in acquiring a second language becomes especially difficult when the language forms learned are those of the mathematics classroom and textbooks. Additionally, the learning of mathematics requires a variety of linguistics skills that second language learners do not readily master. Poor achievement scores of second language learners on national mathematics exams have brought the language used to convey mathematical ideas to students to the forefront of curriculum discussions.

Cognitive Academic Language Learning Approach (CALLA) is an instructional model that prepares students for academic achievement with academic work, language development, and explicit instruction in learning strategies (Chamot & O'Malley, 1994). The two main premises on which CALLA is built are that content should be the primary focus of instruction and that language skills are developed as the need emerges from the content. CALLA is based on research that identified some of the strategies used by effective ESL learners. Once the researchers identified and categorized the strategies used by the students, they taught them to less successful learners. The results of the research showed that when less effective language learners used these strategies they improved markedly. The research also concluded that the teacher and students both must take an active role in the process and that each learning strategy must be chosen appropriately for the task at hand. According to the study, as "students begin to regulate their own learning through a strategic approach to learning tasks; they are no longer totally dependent on the teacher" (Chamot & O'Malley, 1994, p. 20).

Sheltered Instructional Observation Protocol (SIOP)

The Sheltered Instructional Observation Protocol (SIOP) developed by Echeverria and Short (2004), is a research-based framework applicable to the instructional settings for ELLs. The model is designed to meet the needs of students from diverse backgrounds to participate in an instructional setting that shelters them from complex instruction while providing high expectations relevant to the ELLs' diverse linguistic background. The SIOP model acts as a framework of instructional practices and constitutes the flexibility to use various resources and instructional creativity as long as the consistent use of the detailed components is evident in daily instruction.

SIOP involves the use of a comprehensive checklist of strategies that teachers can use in their lesson planning and in their instruction to make content comprehensible to English learners. SIOP is grounded in the research in second language acquisition, bilingual education, and sociocultural theory (CREDE, 1999). SIOP consists of three main areas: preparation, instruction, and review/assessment. Each of these three areas contain numerous headings and subheadings that help to guide the teacher in making the academic content in lessons more accessible to mainstreamed ELLs. There are a total of thirty heading and subheadings, called indicators in the SIOP model. Each component provides detailed examples of complete implementation with teaching scenarios, making practice implementation clear and understandable to the practitioner. The model was developed to provide a way for teachers to systematically implement instructional features for improving the academic achievement of ELLs in content area classes. In recent years, the SIOP model has been developed for the different content areas such mathematics and social studies.

Disciplinary Literacy

Multiple indicators—ranging from flat National Assessment of Educational Progress (NAEP) scores to the Program for International Student Assessment (PISA), ranking African American and Hispanic American students 25th among 32 countries (Brozo, & Topping, 2007)—suggest that the majority of American secondary students do not have the reading and writing skills necessary to negotiate content-area texts. This finding also applies to mathematics texts. An analysis of the 2000 NAEP scores revealed fewer than 20% of U.S. seniors are proficient in mathematics while about a third scored below the basic level. In today's era of standards-based reform that calls upon educators to ensure that all students achieve high standards, poor performance on standardized tests pose a problem for educators across the U.S. (Moje, 2008).

While reading and writing continue to be essential skills for all students, literacy demands become increasingly complex in middle and high school, and students' ability to think critically to construct meaning is crucial. As they move from class to class, learners contend with new and evolving sets of skills that further define literacy within each subject. Students must think visually, build mental models, and interact with others in order to construct meaning from texts. The ability to make meaning from content based texts has been the nexus for literacy; however, Meltzer and Hamann (2004) claim that additional abilities are needed to maximize learning in all disciplines.

At the core, literacy is the ability to read and write; however, with recent interest in adolescent literacy, the definition has expanded (Alvermann, 2008). Meltzer and Hamann (2004) state, "Adolescents who are literate can use reading, writing, speaking, listening, and thinking to learn what they want/need to learn AND can communicate/demonstrate

that learning to others who need/want to know” (p. 2). Moje et al. (2008) define disciplinary literacy as students having the ability to comprehend, integrate, critically relate, employ knowledge, and compose written messages. However, learning must be viewed as a discursive activity and participation in a community of practice within the discipline.

Developing disciplinary literacy instructional programs at middle and high schools is a complex process. Several barriers impede the effort to build effective literacy support into the daily educational experience of adolescent learners. These barriers relate to a complex array of factors: students’ and educators’ belief systems, inadequate professional development, organizational and structural impediments, lack of understanding about what needs to be done, lack of focus, and unwillingness to make the changes necessary to support adolescent literacy development (Moje, 2008). Additionally, many secondary educators view literacy instruction as an elementary school responsibility, believing that secondary school teachers should focus only on teaching content (Meltzer & Hamonn, 2004). Furthermore, at the secondary school level, reading comprehension skills must become increasingly sophisticated to address the demands posed by more challenging academic expectations. However, without strong literacy capabilities, students have little chance of meeting state standards and successfully performing on tests required by the No Child Left Behind Act (NCLB).

Disciplinary Literacy: Motivation and Engagement

In the past five years, much has been researched and written about the key role motivation and engagement play in adolescent academic literacy development. The concept of motivation is one that continually surfaces as an important focus in reading

and learning to read. Motivation is often viewed as one of the determiners of adolescent literacy (Metzler & Hamann, 2004). Motivation (in reading) can be described as the individual's impetus to read when he or she is not compelled to do so by academic assignments. For many secondary students, reading is not a habit of their daily lives (Metzler & Hamann, 2004). This is not the same thing as interest, attitude, or beliefs. One could have an interest in reading, but nevertheless choose not to read. Motivation is the underlying factor that disposes one to read or not.

Metzler & Hamann (2004) argue that adolescent literacy is attracting increased focus because it is becoming increasingly evident that student success as measured by standards-based accountability measures will require specific support for academic literacy development within and across the secondary school curriculum (Snow & Biancarosa, 2003). The motivation and the engagement of students are part of and prerequisite conditions for adolescents' further literacy development (Alvermann, 2001; Kamil, 2003). Therefore, classroom practices that support adolescents' engagement with academic literacy tasks within the context of content-area instruction warrant more attention. Alvermann (2001) sums it up this way: "Adolescents' perceptions of how competent they are as readers and writers, generally speaking, will affect how motivated they are to learn in their subject area classes (e.g., the sciences, social studies, mathematics and literature).

Engagement is the extent that an individual "has integrated reading into his definition of who he is "and willingly reads to the exclusion of other activities, particularly when faced with other choices (Guthrie and Davis, 2003, p. 71). The choice to read independently must ultimately be intrinsically motivated. As adolescents move

into young adulthood, they have an increasing amount of autonomy in determining how they will spend their free time. Students often exhibit far more sophisticated reading when they are in situations away from the classroom (Alvermann, 2008). For example, students engaged in complex reading and writing activities around computer games, when they did not exhibit such behavior in classrooms (Alvermann, 2008). Strategy instruction, in which students are taught how to apply specific strategies, may be critical to increasing students' motivation.

In order to help adolescents to become competent readers and writers, develop voice, and integrate these skills into their self-identities, educators must provide appropriate learning environments. Metzler and Hamann (2004) propose three instructional practices designed to facilitate the social milieu that encourages student motivation to read, write, discuss, and strengthen literacy skills: (1) making connections with students' lives; (2) creating safe and responsive classrooms; and (3) interaction between students and text. Guthrie and Davis (2003) outline six practices for promoting reading motivation: (1) knowledge goals, (2) real-world interactions, (3) an abundance of high-interest texts, (4) support for student choice and self-determination, (5) direct strategy instruction, and (6) collaboration support. Broaddus and Ivy (2007) agree that motivating students to engage with academic tasks is a formidable challenge and a multifaceted endeavor. In similar fashion, Tatum (2008), who contends that students remain trapped in an "achievement-score quagmire," references all three of the related promising practices identified by Metzler and Hamann (2004). However, Tatum also calls for enabling texts to include a social, cultural, political, spiritual, or economic focus. Creating a context that actively supports student engagement with academic literacy tasks

does not just happen, but requires intentionality on the part of the teacher to be fully realized.

Motivation and engagement are critical for adolescent readers. If students are not motivated to read, research shows that they will simply not benefit from reading instruction. As much of the work in motivation and engagement shows, these are critical issues that must be addressed for successful interventions. In fact, motivation assumes an important role in any attempt to improve literacy for adolescents.

Disciplinary Literacy Inside & Outside of School Connections

While research on adolescent literacy learning has escalated recently, few studies connecting adolescent literacy engagement with out of school practices have been conducted. One of these studies conducted by Moje, Overby, Tysvaer and Morris (2008) examined the reading and writing practices of students outside of school. In exploring the sociocultural perspective of students, the group found a disconnect between youth interests in scientific and social issues outside of school and their interests in these classroom content areas. According to Moje, et al., (2008), the participants in the study read and write when they have a coherent purpose centered in a network of social activity.

For content-area teachers to meaningfully and effectively address the inherent challenge of developing academic literacy habits and skills while deepening content area learning, they must correlate textbooks to the students' real life. In a qualitative study, Tatum (2008) found that the content of the text may not be sufficient to engage adolescent readers. Instead, he adds, "...finding an entry point or entry passage to the text may be necessary to get adolescents engaged" (p. 164). Moje, et al., (2008) also

contend that students do read and write outside of school and to effectively reach these students, teachers must acquaint students with high-quality adolescent literature they can identify with. This includes texts with characters that persevere through struggles and books that offer models for identities (Moje, et al, 2008).

In a recent commentary, Alvermann (2008) adds a different perspective on adolescent literacy. Alvermann (2008) contends that adolescent literacy is not only paralleled to reading and writing, but to other modes of communication such as online illiteracies. In this era of multimodal texts, methods for constructing meaning are rapidly changing. Adolescents today take part in designing their own webpages, creating visually and aurally narrated texts, and participating in writing in fan fiction. While not all scholars embrace or view this new literacy as viable or as a replacement for traditional reading and writing practices, there are some important implications for educators to consider. Students participating in online literacies are constructing meaning in a social context (Alvermann, 2008). Content area teachers interested in helping their students with discipline literacy could build content area texts and assignments around available online texts and allow student to reconstruct meaning. Making assignments relevant to students' lives allows them to reinvent themselves as competent learners and develop literacy in the content area (Alvermann, 2008).

Adolescent literacy research offers a clear picture of the teaching and learning practices that support literacy development and enhance content-area learning. The key to adolescent literacy development and content area learning is for most or all of the identified useful practices to occur regularly as part of every student's secondary school experience. Additionally, recent research has confirmed that the way in which students

comprehend texts is connected to their interests, their relationship with the teacher, their assignments of task value, and their literacy identities (Guthrie and Davis, 2003).

Teachers' knowledge of students' strengths, areas of challenge, and socio-cultural backgrounds, as well as their understandings about literacy, can strongly affect the quality of their instruction (Meltzer & Hamann, 2004). The central task of secondary school is to prepare students to become independent learners, who can use reading, writing, listening, speaking, and thinking skills to successfully negotiate their roles as workers, family members, and democratic citizens.

Shanahan and Shanahan (2008) argue that disciplinary literacy should be a focus of middle and secondary school settings. Moving beyond the oft-cited "every teacher a teacher of reading" philosophy that has historically frustrated secondary content-area teachers, the authors' preliminary findings suggest that math experts read their respective texts quite differently (Shanahan and Shanahan, 2008). For students learning a second language while at the same time learning abstract concepts is especially troublesome. For mathematics teachers to prepare second language learners for post secondary life, they, must meaningfully and effectively address the inherent challenge of developing academic literacy habits and skills while deepening content area learning.

Dale & Cuevas (1992) note that content teachers must identify the linguistic demands of the instructional context and plan instructional activities to teach natural language and the formal language of textbooks used in classrooms. A particular predicament for students who are learning a second language is the type of discourse found in mathematics textbooks which are known for their high density, high technicality, and high symbolism, leading to a slower reading rate and the need for

repeated readings of even a very short passage Oxford, 1993). Native speakers of the language typically have difficulty with the discourse features of mathematics textbooks, but the problems are exponentially compounded for second language learners and their teachers who must assist them in learning how to read through the extraneous materials in the textbooks.

Because the design and mathematics textbooks and other instructional materials do not always reflect multiple perspectives inherent to a pluralistic society, they often contain cultural biases. Mathematics teachers must learn to adjust instruction to accommodate the cultural, socioeconomic, and linguistic changes occurring in the ESL student population. To assist their second language learners learn mathematic concepts, teachers must identify critical elements in problems and the learning environment that contribute to increased cognitive demands for students of English as a second language. Additionally, teachers of mathematics must find ways to make mathematics understandable, relevant, and familiar. Math teachers can and must make every effort to reach out to these students to create a class that is both positive and rewarding.

Mathematics Reforms

Reforms in mathematics have de-emphasized manual arithmetic in favor of students' discovering their own knowledge and emphasize conceptual thinking and problem solving. While these standards advocate the importance of reading and writing in the mathematics classroom (Draper and Siebert, 2004), reading and writing suggested by the reforms take place within the larger context of encouraging students to communicate their thinking with others so that students can develop a deep understanding of important mathematical concepts and ideas.

In 2000, the National Council of Teachers of Mathematics (NCTM) developed a landmark document, Professional Standards for School Mathematics (PSSM) with the goal of outlining six principles crucial to the development of a strong mathematics program (McKinney and Frazier, 2008; Moschkovich, 2002). The primary goal of the new reforms was intended to continue the improvement of mathematics education, quality instruction, and equity for all students (McKinney and Frazier, 2008; Moschkovich, 2002). According to Woodward and Brown (2006) the PSSM principals showed promise for minority students who are traditionally placed in low-track, skills-based classrooms.

The PSSM reflect a model that emphasizes discourses and communication and has shifted mathematics classrooms from primarily silent and individualized activities to a “situated-sociocultural view of mathematics cognition” (Moschkovich, 2002, p. 28). Students in mathematics classrooms are now expected to participate in verbal and written mathematical discourse practices. To do so, students must learn the registers of the mathematics language to communicate mathematically.

Moschkovic (1999) contends that bilingual students may be the most affected by the new mathematics reforms because of their lack of proficiency in the English language. With the reforms calling for an emphasis on mathematical communication and on conceptual understanding that require better understanding of the language English language learners may not be able to fully participate in mathematics learning communities (Moschkovich, 2002, 2001; Nasir, Hand and Taylor, 2008).

Efforts to provide rigorous curricula for all students have proven to be considerably more difficult than the crafters of the mathematics reforms anticipated.

McKinney and Frazier (2008) found that despite the frameworks provided by NCTM, traditional pedagogy for teaching mathematics in the classroom still prevails. Similarly, Woodward and Brown (2006) established that a vast majority of mathematics classrooms fell short of meeting the NCTM 2000 standards. The authors also found that replacing general track mathematics for transitional or college preparation classes were only partially successful. Additionally, increasing the rigor of the class without consideration of other factors underestimated the complexities of teaching mixed abilities group.

Determining the Linguistic Needs of English Language Learners in Mathematics Classrooms

The issues involved in teaching English language learners mathematics while they are learning English present many challenges for mathematics teachers and highlight the need to focus on language issues related to teaching mathematical content. A body of research highlights the complexity of mathematical thinking and the ways that such knowledge transfers or fails to transfer into classrooms (Chapman, 2006; Freeman and Crawford, 2008; Moschkovich, 1999, 2002; Nasir, Hand and Taylor, 2008).

For mathematics teachers to plan for diverse populations, they must be able to identify elements of the interaction between mathematics and language and the ways which the elements effect the cognitive demands on English language learners (Campbell, Adams, and Davis 2007). Lessons can then address the critical elements of the interaction through discussion of linguistic, conceptual, and procedural knowledge.

Linguistic knowledge is necessary because mathematics is not limited to computations in isolation; it is dependent on the English language. Mathematics is a language of its own with grammatical patterns and rules. This is especially problematic for ELLs for they are charged with acquiring the English language and at the same time

learning the linguistic challenges of mathematics. In mathematics, students encounter English words like *bring down*, *tree*, *face*, *plane*, *cone*, *net*, *positive* and *negative* that have unique meanings in a mathematical context. Additionally, students must understand mathematical operations that are associated with many different words. In addition to recognizing the meaning behind the words previously listed, students must understand meanings behind complex phrases such as *least common multiple* and *greatest common factor* that are not easily broken apart for meaning.

The second component, conceptual knowledge refers to a person's representation of the major concepts in a system. Examples include being able to answer questions such as, *what is the difference between the units-column and the tens-column in two-column addition problems such as $39+45=$ ___?* This type of knowledge is knowledge rich in relationships and understanding and acts as a network in which the linking relationships are as prominent as the discrete bits of information. By definition, conceptual knowledge cannot be learned by rote. It must be learned by thoughtful, reflective learning.

Conceptual knowledge requires comprehension of the mathematical process in order to choose the correct operation (s) and perform the essential steps to solve the problem presented. To comprehend what the math problem is asking, students need to understand the symbols that represent mathematical concepts just as a reader must be cognizant of how letters represent sounds. Irujo (2007) contends that to solve mathematical problems, students must be able to analyze, interpret, categorize, compare, describe, explain, demonstrate, present, and much more. To use any of these functions of language, students must know what words, phrases, and sentence structure to use and how to use them.

The last component, procedural knowledge is knowing how to control the relevant factors for examining some phenomenon, performing a certain task or completing an activity. Procedural knowledge also means knowing the method of manipulating a specific condition or the technique for implementing a task (Irujo, 2007). This may include the procedures for solving a mathematical equation. For this knowledge students must know the formal or symbolic representation of a language. In math, this means students must have a strong knowledge of rules, algorithms and procedures. However, just as mathematics textbooks differ from another textbook in their approach to teaching a concept, various cultures around the world approach computation using different methods.

Recent research has focused on how students construct knowledge, negotiate meaning and participate in mathematics (Moschkovich, 2002, 2001; Nasir, Hand and Taylor, 2008). While much of this research has focused on monolinguals in mathematics classes, new research has emerged on mathematical communications of language minority classrooms (Moschkovich, 2002). According to Moschkovich (2002) studies can be divided into three areas of thought for teaching mathematics to bilingual students: learning mathematics through acquiring vocabulary, constructing meanings, and participating in discourses.

Learning mathematics through the acquisition of vocabulary emphasizes the acquisition of vocabulary, a key issue for second-language learners. While students grapple with computations and solve traditional word problems, they learn academic vocabulary. However, this vocabulary perspective presents a simplified view of language that uses the notion of lexicon and has crucial implications for instruction (Moschkovich,

2002). With the new math reforms, students are expected to acquire technical vocabulary, develop comprehension skills to read and understand mathematics textbooks and solve traditional word problems.

The second perspective for teaching bilingual students, the construction of multiple meanings, describes learning mathematics as constructing multiple meanings for words rather than just acquiring a list of words. This perspective necessitates the notion of register. Unlike lexicon, the register depends on the situational use of more than lexical items. The analysis of context of situation is broken down into three elements: field, tenor, and mode, which collectively constitute the "register" of a text (Halliday and Hassan, 1989). The tenor is the social activity relevant to a text; the nature of the social interaction taking place and includes the traditional notion of subject matter. The field is answered with several questions: what is happening, and what the participants are engaged in, power, and the how it influences interpersonal choices in the linguistic system. Tenor refers to participants in the happening, including their characteristics and social status. For instance, the strategy chosen for issuing a command depends largely on the tenor of the relationship. The final element is the mode that is the symbolic organization of the text, rhetorical modes (persuasive, expository, didactic, etc.) and the channel of communication, such as spoken/written text. Those three variables can be used to reconstruct the context in which a language is used.

The pervasive belief that ELLs are able to do math easily because it is "nonverbal" has changed. Almost all ESL and math teachers now recognize that coming to understand mathematics is a verbal undertaking. Lack of proficiency in the academic language of mathematics is one of the reasons that students who appear to be fluent in English still

have difficulty achieving in mathematics. For many educators, bringing language and math instruction together is not only relatively new, it can be quite challenging. ELL teachers who had not taught content areas previously are now being asked to lead or support instruction in the math classroom, and many math teachers who do not see themselves as language instructors are now responsible for providing effective math instruction to ELLs.

Second language learners at the secondary school level come from diverse linguistic, cultural, and geographic regions (Capps, Fix, Murray, Ost, Passel, & Herwanto, 2005), and mathematics teachers must focus on this diversity to ensure that they are prepared to individualize instruction to reflect their students' backgrounds and needs. The future of these students and the communities they will reside in when they leave school depend on how successfully schools meet their linguistic and cultural needs. The ultimate success of this challenge depends, in turn, on how effectively teacher education programs prepare new teachers to educate these students.

Because of the differing view in literacy between the field of mathematics and literacy education, mathematic teachers need to be well informed not only of the reforms but of literacy pedagogy as well in order to help their students acquire the mathematics concepts and learn the English language. The differing views of literacy by literacy researchers and content area teachers reflect a larger problem of communication between the two fields of mathematics and literacy education. Draper and Siebert (2004) contend that literature in mathematics education seldom draws upon the research literature from the field of literacy education. In their study, the authors found that while mathematics education research studies depict how students represent their ideas by writing and

symbolizing, they fail to draw upon literacy research (Draper and Siebert, 2004). In a recent study on disciplinary literacy, Shanahan and Shanahan (2008) argue that disciplinary literacy instruction should be a focus of middle and secondary school settings. Their findings suggest that experts from math, chemistry, and history read their respective texts quite differently. For example, the mathematicians and chemists alike noted the challenge of words that had both general and specific meanings. However, unlike the chemists, the mathematicians were adamant that the precise mathematical definition needed to be memorized in order to obtain true understanding of the mathematical meaning in contrast to its more general meaning. The mathematicians also emphasized that letters and symbols signify specific meanings in some cases but, as variables, change their meaning in others. Being able to read these symbols embedded in both English prose and algebraic equations are considered to be crucial. Conversely, literacy researchers seldom specifically address mathematics education or provide examples of what good literacy instruction looks like in the mathematics classroom.

Effects of Mathematics Teachers' Academic Background on the Achievement of English Language Learners

In recent years, teachers' knowledge of the subject matter they teach has attracted increasing attention. To provide students with "highly qualified teachers," No Child Left Behind, 2001 requires teachers to demonstrate subject-matter competency through subject matter majors, certification, or other means. Ball (1990) explains that the focus on subject-matter knowledge has arisen, at least in part, because of evidence suggesting that U.S. teachers lack essential knowledge for teaching mathematics. Additionally, the mathematics achievement scores of students that are not proficient English-speakers are significantly lower than other subgroups (Abedi & Lord, 2001). Poor achievement in

mathematics suggests that meeting the linguistic and academic needs of English language learners is a critical issue in schools (August & Hakuta, 1997).

In an unpublished study, Greenberg, Rhodes, & Stancavage, (2004) found that eighth-grade students taught by certified mathematics teachers achieved higher average scores on the NAEP mathematics assessment than their counterparts taught by non-certified mainstream teachers. Additionally, students whose teachers had earned a major or minor in their teaching field also had higher mathematics scores than students whose teachers had a major or minor in a field other than mathematics. Whether a teacher held a master's degree did not have significant relevance to students' mathematics scores. However, teaching experience was directly related to students' scores. Students, whose teachers had more than five years of experience teaching math, scored significantly higher than those students whose teachers had less experience teaching mathematics.

In a synthesis of quantitative literature on students' mathematic achievement, Ahn and Choi (2004), found a positive relationship between teachers' subject matter knowledge in math and student mathematics achievement. The strength of the relationship between teachers' subject matter knowledge and student mathematics achievement was moderated by different types of indicators of subject matter knowledge and grade level taught, but none of the moderators fully explains the variations among the correlations between teachers' subject matter knowledge and student achievement.

In yet another study, Klecker (2008) defined teacher quality variables: 1) major/minor in mathematics, (2) highest academic degree, (3) type of teaching certificate, and (4) years taught mathematics, on the mathematics average score of eighth-grade students. Using a secondary analysis of the 2007 NAEP, Klecker (2008) confirmed that

an eighth-grade mathematics teacher is more effective with a major or minor in mathematics and a professional degree than teachers who earned generalist degrees. The study further found that a mathematics teacher with a standard teaching certificate and twenty plus years of experience had a positive impact on student scores. The studies previously discussed were conducted in regular mathematics classrooms and none investigated the relationship of teacher background and the achievement of second language learners in a mathematics classroom.

The increasing presence of ELLs in mathematics classrooms, coupled with the poor performance of language minority students on international and U.S. mathematics standardized exams, have increased discussions on the effect of mathematics teachers academic background on the performance of ELLs in mathematics exams. Campbell, Adams, and Davis (2007), Draper and Siebert (2004) and Kabasakalian (2007) contend that part of the reason for the low performance of ELLs has been placed on the lack of teacher preparation on appropriate methodologies for teaching English language learners. Teaching mathematics to students who are simultaneously learning English has created specific difficulties for mathematic teachers who have not been trained in second language acquisition either through teacher preparation programs or specific professional development. Echevarria, Vogt, & Short (2004) argue that teacher preparation programs should examine the knowledge, skills, and dispositions that mainstream teachers need to develop in order to work effectively with both ELLs and fluent English speakers

Gersten & Russel (2000) investigated the knowledge base of effective instruction for English-language learners in elementary and middle school grades. In their study, the researchers worked with five professional work groups consisting of teachers, staff-

development specialists, administrators, and researchers and identified three common themes. The first theme focused on the merger of English-language development with content-area learning. Members of the professional work groups--especially those in supervisory positions--consistently indicated that sheltered content area instruction often led to sacrifices in learning English. Theme two centered on the relationship between promising approaches and the knowledge base on effective teaching. Participants commented that attempts to merge content area instruction with English language instruction while well-intended and conceptually sound, were rarely well-implemented. The final major theme that emerged: confusion, tension, and assumptions about oral language use revealed the confusion that abounds concerning the role of oral language in academic instruction.

In a different study on the education of teachers of ELLs, De Jong & Harper (2005) surveyed 417 institutes of higher education and found that fewer than one in six required any preparation for mainstream elementary or secondary teachers regarding the education of ELLs. This finding suggests that the preparation of teachers for diverse, native English-speaker classrooms is limited across the United States. The study also reveals that most teacher preparation programs do not offer teaching practices that will be sufficient to meet the specific linguistic and cultural needs of ELLs (Grant & Wong, 2003).

Mathematic Teachers Quality

Prompted by the NCLB's (2001) mandates and the low performance on standardized mathematics tests, the quality of teachers particularly the quality of mathematics teachers has become the center of public education debates. Currently

researchers and policy makers alike agree that teachers are an important if not the most critical component in school quality (Alvarez, 2008). Teacher quality has become an important issue in current education reforms and has placed an emphasis on properly understanding the meaning of teacher quality.

A review of current literature reveals the inconsistency in defining teacher quality (McKinney and Frazier, 2008). As defined in the NCLB (2001), a *highly qualified* teacher holds at least a bachelor's degree; holds full certification or has passed a teacher licensing examination (as dictated by a state licensing agency); and holds a license to teach that is not classified as emergency, temporary, or provisional (Bolyard and Pakenham, 2008). Furthermore, *highly qualified* teachers must demonstrate competence in subject knowledge and teaching skills. In his literature review, Alvarez (2008) found a lack of research on teacher educational background, certification and training, and staff development as predictors of student achievement. While characteristics of quality schools have been identified and reported, there is little research on teacher attributes or observable teacher characteristics that lead to increasing student achievement of ELLs (Alvarez, 2008).

In their study of teacher quality Bolyard and Pakenham (2008) divide the body of literature on teacher quality into two major categories. (a) key policy, public, and practitioner documents focused on mathematics and/or science teacher quality, and (b) relevant studies that correspond to mathematics and/or science teacher quality characteristics. The first section, key policy, public, and practitioner documents, highlighted the importance of quality mathematics and science education in preparing students to be competitive in an increasingly global society. This section identified

improvement of teaching as the best way to achieve that goal and described a vision of high-quality teaching that places deep content knowledge at its foundation. A second perspective in the government documents as identified by the National Board for Professional Teaching Standards defines mathematics and science teacher quality as *accomplished teaching*. In addition to meeting the mandates of NCLB (2001) for *highly qualified*, an *accomplished* teacher must document and analyze student learning and teaching practices.

Low performance on standardized mathematics tests, have prompted policy makers and researchers to examine the relationship between student mathematics achievement and teachers' subject matter knowledge. Despite the wide interest in what counts as content area knowledge, it has remained inadequately specified in past research (Hill, Rowan, and Loewenberg-Ball, 2005). In their study on the effects of teacher mathematics subject matter knowledge and student achievement, Hill, Rowan, and Loewenberg-Ball (2005) found that researchers have primarily measured teachers' knowledge using proxy variables, such as courses taken, degrees attained, or results of basic skills tests. Hill, Rowan, and Loewenberg Ball (2005) also found that another group of researchers maintain that teacher effects on student achievement are driven by teachers' ability to understand and use subject-matter knowledge to carry out the tasks of teaching. According to this view, mathematical knowledge for teaching goes beyond mathematics courses taken or basic mathematical skills to the pedagogy of presenting difficult concepts and procedures in a context that students can understand.

Several studies find a positive effect of experience on teacher effectiveness. Teachers who have earned advanced degrees have a positive impact on high school

mathematics achievement when degrees earned are in those subjects (Bolyard and Packerham, 2008). Research demonstrates a positive effect of certified teachers on high school mathematics achievement when the certification is in mathematics (Hill, Rowan, and Loewenberg Ball, 2005). However, studies show little impact of emergency or alternative route certification on student achievement in mathematics compared to standard certification. Teacher coursework in both subject area taught and pedagogy contributes to teacher effectiveness at all grade levels. Additionally tests that assess teachers' literacy levels or verbal abilities are associated with higher levels of student achievement.

Professional Development and Adult Education

In recent standards-based zeal to improve learning and achievement for all students, professional development is viewed as central to educational reform (Elmore, 1996). In relation to the reform standards, teacher quality has also come to the forefront in discussions of educational reform. Reformers are paying considerable attention to the role that effective professional development can play in improving the teaching of mathematics. Some national efforts, such as those by the National Council of Teachers of Mathematics and the National Research Council, come from those who are interested in improving particular subject matter, as well as teaching and assessment.

Clair and Temple Adger (1999) maintain that professional development for teachers should incorporate the principles of adult learning. Adult learners need to be self-directed; display readiness to learn when they have a perceived need; and desire immediate application of new skills and knowledge (Knowles, 1980). Effective professional development should be embedded in the reality of schools and teachers'

work and should be designed with teacher input, so that it fosters critical reflection and meaningful collaboration. Guskey (2002) contends that professional development will not be effective if it is not correlated to standards teachers must address. Rueda (1998) adds that promising professional development should be aligned with effective teaching and learning and should not differ for adults in general and teachers in particular.

Professional development should be internally coherent and rigorous, and it should be sustained over the long term (Mezirow, 1981; Knowles, 1989; Lindeman, 1989; Guskey, 2002; McIntyre, 2010). Additionally, professional development should afford teachers opportunities to seize ownership in the planning and implementation structure and delivery of the sessions. Weiss and Pasley (2006) discovered that professional development that was precisely designed and enthusiastically supported led to instructional change within 30 hours. In 80 hours, the professional development produced further improvements. One-shot or multi-day inservices that do not relate directly to classroom instruction are likely to be futile.

August and Shanahan (2006) add that the facilitator of professional development is central to the success of the sessions for this person must motivate and inspire. Additionally the authors contend that because change is time consuming and requires considerable investment on the part of change agents as well as teachers, long-term projects are generally more successful than short-term projects. Finally, staff development projects that affect long-term teacher practice are those that focus on strategies for teaching critical thinking.

In 2000, the National Commission on Mathematics and Science Teaching for the 21st Century called for an ongoing system to improve the quality of mathematics and

science teaching in grades K-12. Garet, Porter, Desimone, Birman and Yoon (2001) found that on the average student achievement in mathematics was higher in situations where teachers had participated in extensive and continuous professional development that focuses on teaching specific mathematics content. Based on their study of professional development sessions, Cohen and Hill (2000) argue that to alter the core elements of teaching requires “extended opportunities for teachers to learn, generous support from peers and mentors, and opportunities to practice, reflect, critique and practice again” (p. 307). According to Spark and Richardson (1997) the National Staff Development Council recommends that teachers dedicate 25% of each school day to working together, collaboratively planning lesson, and sharing information.

The adult education elements and structures supported by Knowles (1989) and Guskey (2002) are important for designing professional development; however, they are not sufficient for teachers working with second language learners. In addition to content based knowledge, professional development for teachers with ELLs must address knowledge and attitudes that are relevant to teaching second language learners. To be successful in teaching ELLs, teachers need to understand basic constructs of bilingualism and second language development, the nature of language proficiency, the role of the first language and culture in learning, and the demands that mainstream education places on culturally diverse students (Clair, 1993). Teachers need to continually reassess what schooling means in the context of a pluralist society; the relationships between teachers and learners; and attitudes and beliefs about language, culture, and race (Clair, Adger, Short, & Millen, 1998; González & Darling-Hammond, 2000).

Gonzalez & Darling-Hammond, (2000) maintain that content area teachers with ELLs in their classroom should be provided opportunities to connect theory to practice in tightly integrated ways; support in learning how to understand what students bring to the classroom; concrete strategies that shape collaborative learning environments and build on students' language, culture, and experience; ongoing opportunities for collaboration and collective problem solving; and experiences that allow them to learn and work professionally in the same ways that they hope to teach.

Conclusion

English Language Learners (ELLs) constitute the fastest growing portion of the K-12 student population (Garcia, Kleifgen and Flachi, 2008; Goldenberg, 2008). The growth of this subgroup brings many challenges to classroom teachers particularly to those who teach mathematics. Now more than ever, teachers are challenged to provide these students with opportunities to use discipline specific language in communities of learning, reading, speaking and writing. Additionally for many educators, the challenge of bringing language and mathematics instruction together is a relatively new one.

Beyond the need to support bilinguals in school, some specific needs warrant particular attention. Traditionally, ELLs have not performed well in math. Therefore, it is critically important to understand the effective teaching practices and positive learning environments that support second language learners in mathematics classes. Current research indicates that teachers must be cognizant of their students' language proficiency and align their strategies to the recommendations of both mathematics standards and literacy pedagogy (Moschkovich, 1999).

Gutierrez (2002), Guthrie and Davis (2003), and Meltzer and Hamann (2004) reinforce Sherris' (2008) premises that instruction for ELLs must be built on integrated content and language instruction, and add that students must be provided with opportunities to work collaboratively in groups and be allowed to use the language in which they can best relate to mathematics concepts. Gutierrez (2002) contends that school administrators need to structure opportunities for teachers of mathematics to come together to develop materials and strategies that will help make mathematics more accessible to their particular students, as mathematical and cultural or linguistic learners. With these elements in place, ELLs can experience academic success.

The next chapter outlines the research design, methods, and procedures used for conducting research in the secondary mathematics classroom. Chapter 3 describes the development of the instruments used to compile data, data collection methods and analysis, and data analysis procedures. The chapter has the following sections: 1) population and sample, 2) unit of analysis, 3) instrument design and development, 4) survey administration, 5) data analysis strategy, and 6) a review of methodologies used in studies of mathematics and English language learners.

Chapter 3: Research Design and Methodology

Introduction

The education of English Language Learners (ELLs) poses significant challenges for public schools education system. The number of children and youth with limited English language proficiency in U.S. public schools is steadily increasing. Recent information from the Migration Policy Institute (2010) depicted that in the school year 2007-2008 ELL enrollment in U.S. public schools compromised more than 10 percent of the total student population of approximately 49.9 million. Public schools in Texas received burgeoning numbers of ELLs, second only to the state of California. Of the total Pre-K-12 enrollment in Texas, 4.6 million, over 700,000 students were classified as ELLs, a 38.4 % increase since the 1997-1998 school year (Migrant Policy Institute, 2010).

Chapter 3 provides the purpose of this cross-case analysis and presents the purpose of the study. The purpose of the current qualitative study is to determine the pedagogical and instructional practices and types of professional development middle school mathematics teachers need to be effective in meeting the needs of English language learners in the mathematics classroom. Additionally, the study examines the effects of mathematics teachers' academic background on the academic achievement of second language learners through case studies of three middle school mathematics teachers in a school district in close proximity to the southern Texas/Mexico border. This introduction is followed by a description of the problem, research questions, literature review of relevant research studies, population, and sample used in the study, data collection, data analysis, and conclusion.

Problem

The increasing number of second language students combined with new standards and standardized testing has changed the dynamics in the mathematics classroom. Mathematics teachers must now impart more challenging mathematical concepts while many students are simultaneously learning the dominant language. The increasing presence of English Language Learners in U. S. schools, the poor performances of language minority students on international and U.S. mathematics standardized tests and mathematics achievement as a reliable predictor of success in secondary and post secondary has repositioned English as a second language (ESL) pedagogy in the mathematics curriculum discussions. Campbell, Adams, & Davis (2007), Draper & Shiebert (2004) and Kabasakalian (2007) contend that part of the rationalization behind the low performance of ELLs has been placed on the lack of teacher preparation on appropriate methodologies for teaching English language learners. Teaching mathematics to students who are simultaneously learning English has established specific difficulties for mathematic teachers. The challenges faced by ELLs in mathematics classes are exacerbated by the fact that only about 15% of secondary school math teachers have specific training in working with students who are not proficient in English (Combs, Evans, Fletcher, Parra, & Jimenez, 2005; Coates, 2006).

In addition to identifying the linguistic demands of the instructional context for English and non-English speakers, educators must also plan activities to teach natural language and formal mathematics academic language. Additionally teachers of mathematics must also plan for the cultural, socioeconomic and linguistic changes occurring in the language minority population. An analysis of the 2009 National

Assessment of Educational Progress (NAEP) results confirmed a trend of systemic underachievement among English language learners. The scores for this group of students on tests such as the NAEP fall below those of Anglo-American and African American students, and the gap between NAEP scores for Whites and Hispanics did not change significantly in the past decade according to 2009 NAEP mathematics results (National Center for Education Statistics [NCES], 2009). The same trend can be found in the state of Texas where the Texas Assessment of Knowledge and Skills (TAKS) is administered in the four content areas every spring to students in grades three through eleven. Analysis of the 2010 seventh-grade mathematics TAKS, revealed that ELL's school performance is far below that of other students, oftentimes ten to twenty percentage points. While the ELL group has made gains since the first administration of the TAKS mathematics exam, the gap between this subgroup and other student subgroups has not narrowed.

Research Question and Sub-Question

Research Question 1 What instructional practices do middle school mathematics teachers in this cross case study use in classes with ELLs? Sub-question: How do their different practices result in differential student achievement between mainstream students and ELLs?

Research Question 2 What effect does the academic background and professional development of mathematics teachers in this cross case study have on the academic achievement of their second language learners?

Review of Research

Introduction

This review encompasses literature that addresses the research questions. The

review covers key mathematics education literature published in the *Journal of Education Research*, *Journal of Teacher Education*, *American Education Research Journal*, and *Sage Publications*. Most of the studies focus on mathematics education for diverse learners. Specifically, the literature review is comprised of studies that address the following topics: *English Proficiency and Mathematics Achievement*, *Mathematics Teacher Knowledge*, *Mathematics Teachers' Teaching Experience*, *Teacher Academic Background* and *Professional Development*.

The small but growing body of research on ELLs in secondary mathematics classrooms has moved beyond deficit theories and issues of assessment to address how educators can provide a high-quality mathematics education for all students (Moschkovich, 2000, 1999a, 1999b; Beal, Adams and Cohen, 2010; Rosa, 2011; Lucas, Villegas, Freedson-Gonzalez, 2008; Chang, 2008; Walshaw & Anthony, 2008; Leonard, 2009; Brooks and Thurston, 2010; Gutierrez, 2002; Bol and Berry, 2005) Zvoch & Steens, 2006); and Gutierrez, 2009). This body of research highlights the complexity of teaching and learning when students are learning English as a second language and simultaneously learning mathematics as a language, the effect of teacher preparation and experience on student achievement, and the relationship between teachers' college course-taking patterns and professional development and student achievement.

English Proficiency and Mathematics Achievement

In a quantitative study, Walczyk & Griffith-Ross (2006) studied the scholastic performance of one hundred forty undergraduates who agreed to resolve algebraic inequalities under time pressure or under no time pressure. Participants were also assessed on the efficiency of the subcomponents required to execute the criterion

algebraic inequality task (e.g., number identification, computation latency).

This quantitative study was grounded on the compensatory-encoding theory C-ET that was designed to capture more general principles underlying scholastic performance. The methodology of this study included an analysis and multiple regressions of the results from testing how the efficiency of performance subcomponents affects comprehension under diverse task conditions. Results of the quantitative study indicated that if working memory must be devoted to low-level operations, there are fewer cognitive resources available to allocate to higher-order problem-solving activities, such as forming an appropriate problem representation, identifying needed information, and checking progress toward the solution. By implication, students who must devote substantial cognitive resources to English comprehension will have less capacity available to devote to math problem-solving operations. The notion that ELLs' lower math achievement reflects differential opportunity to learn in the classroom is consistent with research on cognitive processes in mathematics problem solving.

In a mixed methods study, Beal, Adams and Cohen (2010) examined the relationship of English proficiency and math performance in a sample of ninth grade students including ELLs (47% of the class composition) enrolled in an algebra I class. The mixed methods study examined two areas: math performance for students varying in English proficiency, and the impact of English proficiency on the mathematics motivation of ELLs. Through the use of one-way analysis for variance, regression models, and log-odds correct scores the researchers examined the quantitative data: state math test scores, study-specific pre- and posttest scores, problem solving in an online math tutorial, and scales scores of a state English language development test. Qualitative

data, obtained from responses to a self-report assessment of mathematics self-concept and a teacher three-level checklist were analyzed with a five-point Likert-type rating scale.

The results of the Beal, Adams and Cohen (2010) mixed methods study indicated that many of the grade 9 students were struggling with basic math. The majority scored far below basic or below basic on the state achievement test. Additionally teachers rated almost half of their students at risk of failing the algebra class. The ELLs in the algebra class scored below their counterparts who were fluent in the English language. In this study, English reading skills were significantly related to math performance and English proficiency predicted performance on the state math achievement test, scores on the software pretest, the proportion of word problems correctly solved in the software, and progress through the software curriculum.

In another mixed-methods study, Abedi, Courtney, Leon, Kao and Azzam (2006) investigated the interactive effects between students' opportunity to learn (OTL) in the classroom. The study included two language-related testing accommodations, English language learners (ELLs), and students of varying language proficiency, and how these variables impact mathematics performance. 2,321 grade 8 students were administered one of three versions of an algebra test: a standard version with no accommodation, a dual-language (English and Spanish) test version accommodation, or a linguistically modified test version accommodation. Students' scores from the prior year's state mathematics and reading achievement tests, and other background information were also collected. Qualitative data was derived from observations of 369 of these students during one class period for student-teacher interactions. These students' teachers were administered a teacher content knowledge measure

Through the use of hierarchical linear modeling, Abedi et al (2006) investigated three class-level components of OTL: (1) student report of content coverage; (2) teacher content knowledge; and (3) class prior math ability (as determined by an average of students' grade 7 math scores), two language accommodations, and ELL status. Results indicated that all three class-level components of OTL were significantly related to math performance and that teacher content knowledge had a significant differential effect on the math performance of students grouped by a quick reading proficiency measure, but not by students' ELL status or by their reading achievement test percentile ranking. The results suggested that, in general, ELLs reported less content coverage than their non-ELL peers, and they were in classes of overall lower math ability than their non-ELL peers.

Table 1
Studies in English Proficiency and Mathematics Achievement

| Article | Research Methodology | Research Design |
|---|----------------------|--|
| Walczyk & Griffith-Ross (2006) | Quantitative | Methods: Factor analysis on numeric efficiency measures, Varimax orthogonal rotation |
| Wang & Goldschmidt (1999) | Quantitative | Methods: Multiple regression; inferential statistics of tests |
| Beal, Adams, & Cohen (2010) | Mixed Methods | Quantitative Methods: log-odds correct answer; one- way analysis of variance; regression model Qualitative Methods: Likert type rating scale, three-level checklist |
| Abedi, Courtney, Leon, Kao and Azzam (2006) | Mixed Methods | Quantitative Methods: hierarchical linear modeling |

To date, there has been relatively little investigation into how limited English proficiency influences students' mathematics learning. One relevant concept is the notion of the student's "opportunity to learn," meaning that there is more to learning than the student's physical presence in the classroom (Wang & Goldschmidt, 1999). More specifically, if the student cannot easily understand the teacher's explanations or the

textbook materials, he or she will not benefit from the instruction to the same extent as an English- proficient student (Secada, 1996; Carpenter, Franke, and Levi, 2003; Guerrero, 2004).

Mathematics Teacher Knowledge

In multi-year, qualitative multiple case study, Guitierrez (2002) examined the practices, beliefs, and consequences of three high school mathematics teachers that teach low-income primarily English language learners in an advanced mathematics classroom. The data was obtained from semi-structured interviews with teachers and open-ended surveys with students over a thirteen-month period. Interviews and field notes were coded for major concepts such as language, culture, instructional strategies, and communication in mathematics. Results for the study indicated that while the teachers in the study were not bilingual, the practices implemented in instruction mirrored those proved to be effective when teaching second language learners.

In a quantitative study, Darling-Hammond (1999) examined the ways in which teacher qualifications and other school inputs are related to student achievement across states. Darling-Hammond (1999) used the data from a 50-state survey of policies, state case study analyses, the 1993- 94 Schools and Staffing Surveys (SASS), and the National Assessment of Educational Progress (NAEP). The most consistent highly significant predictor of student achievement in reading and mathematics in each year tested is the proportion of well-qualified teachers in a state: those with full certification and a major in the field they teach. The strongest, consistently negative predictors of student achievement are the proportions of new teachers who are uncertified and the proportions of teachers who hold less than a minor in the field they teach Quantitative analyses

indicated that measures of teacher preparation and certification are by far the strongest correlates of student achievement in reading and mathematics, both before and after controlling for student poverty and language status.

In mixed methods study, Hill, Rowan, and Loewenberg Ball (2005) explored whether and how teachers' mathematical knowledge for teaching contributes to gains in students' mathematics achievement. Data were derived from two major sources: student assessments and parent interviews for 115 elementary schools, a log that teachers completed up to 60 times during one academic year and an annual questionnaire filled out during each year of the study.

Using a linear mixed model methodology in which first and third graders' mathematical achievement gains over a year were nested within teachers, who in turn were nested within schools. The study found teachers' mathematical knowledge was significantly related to student achievement gains in both first and third grades, controlling for key student and teacher-level covariates. The result provides support for policy initiatives designed to improve students' mathematics achievement by improving teachers' mathematical knowledge.

In a quantitative study, Zvoch and Stevens (2006) investigated the school context and teacher practice effects on the academic performance and growth of middle school students. Quantitative data was gathered from state mandated norm referenced achievement exams, student demographics, mathematics teacher education attainment, and the mathematics curricula implemented at the time of the study. Multi-level modeling techniques were used to avoid methodological limitations cited in previous school effects investigations. To study student-achievement growth over time, the researchers analyzed

the item-response theory (IRT)-derived scores. The middle school mathematics teachers delivered three of four mathematics curricula. Three of the curricula had been newly developed and reform-based approaches for delivering mathematics instruction.

Results of the study revealed two patterns. School context, as measured by student and school demographic characteristics, both related closely to mathematics performance level but had little relationship with mathematics growth rates. Results indicated that one additional year of teacher educational attainment was associated with a 3.25 point yearly increase in the average mathematics growth of students. Additionally, schools using a traditional approach to teaching mathematics outperformed schools that adopted one of the reform curricula by approximately 3 scale-score points per year.

Identifying effective discursive practices in domain-specific areas, such as, mathematics is a more recent research endeavor (Ball, Lubienski, Mewborn, 2001; Shulman, 1986; Stein, 2001). As a result, an understanding of what quality mathematics pedagogy looks like, specifically in relation to the vision of community production and validation of mathematical ideas, is still in its formative stages. The National Council of Teachers of Mathematics (NCTM, 2000) has provided guidelines as to what teachers can do to enhance effective classroom discourse: “Effective teaching involves observing students [and] listening carefully to their ideas and explanations” (p. 19).

Accumulated research findings in past decades have led to the understanding that teachers’ knowing mathematics for teaching is essential to effective classroom instruction (RAND Mathematics Study Panel, 2003). Corresponding efforts have also been reflected in teacher preparation programs that call for more emphasis on prospective teachers’ learning of mathematics for teaching (Conference of Mathematical Sciences [CBMS],

2001; National Council of Teacher of Mathematics [NCTM], 2000). Such efforts can presumably increase the quality of pre-service teacher preparation and prospective teachers' confidence and ultimate success in future teaching careers.

While some evidence suggests that better qualified teachers may make a difference for student learning in the classroom, school, and district levels, there has been little inquiry into the effects on achievement that may be associated with large-scale policies and institutional practices that affect the overall level of teachers' knowledge and skills in a state or region (Darling-Hammond, 1999).

Table 2
Studies in Mathematics Teacher Knowledge

| Article | Research Methodology | Research Design |
|---|---|---|
| Gutierrez (2002) | Qualitative multiple case study | Interviews, surveys, observations, field note |
| Darling-Hammond (1997) | Quantitative Data: National Center for Education Statistics; NAEP 1996 Mathematics Report Card for the Nation and the States; 1993-94 SASS database | Quantitative Methods: multivariate analyses, initial bivariate correlations |
| Hill, Rowan, and Loewenberg Ball (2005) | Quantitative Data: state exam scores Qualitative Data: surveys, questionnaires, observations | Quantitative Methods: linear mixed model; standardized regression models Qualitative Methods: regression models; Bayesian methods; PROC MIXED procedure in SAS |
| Zvoch and Stevens (2006) | Quantitative Data: norm reference state exam scores; teacher education level; mathematics curricula | Quantitative Methods: multi-level modeling techniques; (IRT)-derived scores; curricula coding |

Mathematics Teachers' Teaching Experience

In a qualitative, naturalistic study, Chapman (2006) investigated teachers' treatment of context of word problems in their classrooms. The study included fourteen experienced teachers from different schools and grade levels. The main sources of data were open-ended interviews, and classroom observations. Bruner's (1985, 1986) two modes of knowing, paradigmatic (logico-scientific) and narrative (humanistic), provided

a basis for making sense of how teachers deal with context in their teaching of word problems. Data analyses consisted of open-ended coding focusing on significant statements and actions that reflected judgments, intentions, expectations, and values of teachers regarding word problems. These attributes were grouped into themes and validated by comparison of findings by the reviewers and triangulation of findings from interviews, classroom observations and role-play, teacher artifacts.

Results of the study indicated that early grades elementary teachers related their teaching approaches to dealing with problem context to the developmental level of the students. The later grades elementary teachers related their approaches to the nature of mathematics and the developmental level of the students. The middle school teachers related their approaches to the nature of mathematics and the nature of the learner, e.g., they are inseparable from their experiences. The high school teachers related their approaches mainly to the nature of mathematics. The assumption here is that the way the teachers dealt with context was influenced by how they viewed it mathematically and how they viewed the students as learners.

In recent years, mathematics teachers have become a focus of research and have been studied in terms of their knowledge, beliefs, classroom practices, and learning. Some studies have indicated that preservice teachers, in particular, possess the same context issues as do students. Verschaffel, De Corte, and Borghart (1997) contend that preservice teachers tend not only to exclude real-world knowledge from their own spontaneous solutions of arithmetic word problems they dismiss it from their students' solutions. Additionally, in their study, Contreras and Martinez-Cruz (2001) learned that preservice elementary teachers did not always base their responses to mathematical

computations on real life situations. In a review of the literature, Chapman (2006) found that little attention has been placed on the actual teaching of word problems and no emphasis on the teacher's perspective of how to deal with mathematical context in the classroom. Studies generally measure teaching experience in terms of either teachers' total years of teaching or teachers' years of teaching in a given district (Bolyard and Moyer-Packenham, 2008). A few studies examine the impact of these measures on students' mathematics and science achievement.

Table 3
Studies in Mathematics Teachers' Teaching Experience

| Article | Research Methodology | Research Design |
|----------------|---------------------------|---|
| Chapman (2006) | Qualitative, naturalistic | Triangulation; Observations, interviews, role-play, teacher artifacts |

Teacher Academic Background

In a qualitative ethnographic case study, Brilhart (2010) examined the disconnect between teacher preparation programs and classroom teaching with ten in-service mathematics teachers. Through observations, field notes, questionnaires, and interviews, Brilhart (2010) found that teachers looked to their pasts to make sense of their presents. The study revealed that teachers need to have rich and complex experiences of teacher-student relationships, or other similar type of roles, to process how to think about their teaching. Teacher growth was evident when looking at teachers with more experience and was greatly dependent on a teacher's increasing understanding of relating to students.

Findings indicated lessons learned and remembered during teacher education courses had certain qualities. Teachers remembered lessons taught by education professors who involved them either as students or as teachers. In-service teachers also

remembered and used memories from teacher education activities that required or supported personal choice and personal vision-building.

Table 4
Studies in Teacher Academic Background

| Article | Research Methodology | Research Design |
|-----------------|--------------------------------------|---|
| Brilhart (2010) | Qualitative, ethnographic case study | Observations, field notes, questionnaires, and interviews |

While the volume of research on teachers' qualifications has grown, it has not settled arguments about the merits of teacher education programs. Darling-Hammond & McLaughlin (1999) documented more than 200 studies that found teachers who have more background in their content areas and have greater knowledge of teaching and learning are more highly rated and more successful with students in fields ranging from early childhood and elementary education to mathematics, science and vocational education (pp. 377–378).

Rowan, Chiang, and Miller (1997) found a positive association between teachers holding a degree in mathematics and grade 10 students' mathematics achievement although the effect was small. Chaney (1995) found that eighth-grade students whose teachers had taken course work in both advanced mathematics (higher than calculus) and mathematics education had the highest mean standardized scores on NLES:88 mathematics test; students of teachers who had taken neither class of courses had the lowest mean standardized score. Monk (1994) found that courses in undergraduate mathematics pedagogy contributed more to secondary students' achievement gains than did undergraduate mathematics coursework. Goldhaber and Brewer (1997a, 1997b) found that teachers' holding bachelor's or master's degrees in mathematics had a statistically significant positive relationship to high school students' mathematics

achievement in comparison to teachers without advanced degrees or out-of-subject degrees. In a later study Goldhaber & Brewer (2000) found similar positive results for teachers' having a BA or MA on secondary students' mathematics achievement.

Professional Development

In a quantitative study, Desimone, Smith, & Ueno (2006) examined the relationship between middle school math teachers' background in and knowledge of mathematics and their participation in content-focused professional development. The authors used the teacher questionnaire in the 2000 NAEP Mathematics Assessment eighth grade national sample that includes data on teachers' educational background, their perceived level of preparedness to teach a range of mathematics topics, the ability level of the classes they teach, and the amount of time they spent in content-related professional development.

For analysis of the data, the group implemented the multinomial logistic model to estimate a unique set of coefficients for the comparison between brief and medium-length content-focused professional development, and for the comparison between medium-length and sustained content-focused professional development.

To examine whether undergraduate and graduate mathematics majors jointly predicted professional development participation, further analyses was conducted with the Wald test. The findings indicated that although an undergraduate major does not independently significantly predict participation in sustained content-focused professional development, the joint effect of undergraduate and graduate major does significantly increase the likelihood that a teacher will participate in sustained content-focused professional development, compared to medium-length professional

development.

Additionally, the study concluded that among teachers with the same educational credential (e.g., a bachelor's degree in mathematics), those that feel more prepared to teach a different range of mathematics topics are more likely to take sustained content-focused professional development and less likely to take brief content-focused professional development than their counterparts who report being less prepared. The results also indicated that teachers of mixed-ability classrooms tend to take more sustained content-focused professional development than their colleagues who teach low- or advanced-ability classrooms. The study also provided strong evidence that teachers with the weakest content knowledge in mathematics are not the ones receiving sustained content-focused professional development. Teachers with more expertise in mathematics feel more confident and motivated to seek out such professional development, although teachers with weaker content knowledge may not have the interest in intensive mathematics-focused professional development, or may not think their knowledge and skills are sufficient to meet the demands of such activities.

Table 5
Studies in Professional Development

| Article | Research Methodology | Research Design |
|--------------------------------|--|---|
| Desimone, Smith, & Ueno (2006) | Quantitative: teacher background survey on 2000 8 th grade mathematics NAEP | Multinomial logistic model; Risk Ratios (RRR) |

Professional development has become a cornerstone of the current reforms in mathematics. Over the past decade a considerable amount of literature has emerged on professional development, teacher learning, and teacher change (Desimone et al, 2006). This literature has provided meaningful insight into “high-quality” professional

development—qualities of professional development that make it successful for increasing teachers' knowledge and skills, changing teaching practice, and improving student achievement. Consistent with the “best practice” literature, recent large-scale studies have shown that high-quality professional development programs include (a) longer contact hours; (b) activities sustained over long periods of time; (c) participation by teachers from the same grade, school, or subject; (d) active learning opportunities; (e) coherence with other reform efforts; and (f) a focus on subject-matter content (Desimone, Porter, Garet, Suk Yoon, & Birman, 2002; Garet, Porter, Desimone, Birman, & Yoon, 2001).

In particular, sustained, content-focus professional development has emerged as perhaps the most important type of in-service teacher education. Recent findings have shown that professional development focused on specific content is associated with changes in teaching practice (Cohen & Hill, 2000; Desimone, Porter, et al., 2002; Garet et al., 2001) and that participation in such activities is positively related to student achievement (Cohen & Hill, 2000; Kennedy, 1998; Wenglinsky, 2000, 2002).

Theoretical Framework

The theoretical framework for this study drew on sociocultural theories of learning, and related formulations of Vygotsky's notion of the zone of proximal development (ZPD), as providing a coherent rationale for classroom practices that develop students' mathematical thinking (Goos, Galbraith and Renshaw, 1999). Vygotsky defined the zone of proximal development (ZPD) as a framework which “brings all of the pieces of the learning setting together—the teacher, the learner, their social and cultural history, their goals and motives, as well as the resources available to

them, including those that are dialogically constructed together” (p. 468).

Vygotsky (1934/1978) saw the primacy of the social in the zone of proximal development (ZPD). The tenets of a socio-cultural theoretical framework provide key components for defining the social in literacy. Social is defined with respect to the model of language, the model of acquisition, and the model of research. In the field of second-language acquisition, the dominant cognitive paradigm sees the role of “social” as a factor. However, in a sociocultural approach, the social cannot be taken out of the equation. The social in the dialogic model of research involves an emphasis on investigation of literacy in local contexts and situated knowledge (Wong, 2006). In doing so the study focused primarily on the micro social context of classroom interactions, while also considering aspects of the broader macro-context such as teachers’ and students’ beliefs about school mathematics learning (Abreu, 2000).

Research Design

This study adopted a qualitative, case cross analysis study approach to explore the actions and backgrounds of three mathematics teachers in their communities of practice and to seek answers to the proposed research questions. The conceptual framework that supports this research design is the case study theories of Stake (1995) and Yin (1984). Yin (1984) defines the case study research method as an empirical inquiry that investigates a contemporary phenomenon within its real-life context; when the boundaries between phenomenon and context are not clearly evident; and in which multiple sources of evidence are used (p. 23).

Stake (1995) contends that the case study methodology is an effective procedure for studying educational issues. As Stake (1995) points out, the case study approach

emphasizes the study of classroom experience, personal interaction, and institutional processes and contexts. The cross case study was selected because teacher education has consistently acknowledged that teacher learning is best when it is situated in real-world teacher practice (Wilson, Floden, and Ferrini-Mundy, 2004; Lane, Lane, and Kyprianou, 2004; Davis and Krajcik, 2005). Additionally, evidence is mounting that the case study method can be an effective way of communicating the detailed, interrelated processes necessary to unpack the multidimensional nature of what students and teachers do in classrooms (Briza, Nardi, and Zachariades, 2007).

The case cross analysis methodology allows the researcher to place emphasis on teacher-led inquiry discussions and student-oriented approaches (eg, group inquiry). Probing into student understanding provides teachers with the opportunity to model engagement within a mathematical, multi-voiced community (Moschkovich, 2001), with a view toward advancing students' understanding of appropriate mathematical conventions (Hiebert, Carpenter, Fennema, Fuson, Wearne, and Murray, 1997). Sherin (2002) agrees and adds that in classroom exchanges of ideas, typically, teachers negotiate between three areas of knowledge: their understanding of subject matter, their perception of curriculum materials, and their personal theories of student learning.

This case cross analysis was conducted in a mid-sized school district in South Texas. Student socioeconomic status was low with 92% of middle school students receiving free or reduced-price lunch (FRL). The campus is also racially diverse, with a population that is 99% Hispanic and 1% White and African American. 33% of the student population is classified as limited English proficient and 57% is at risk of not obtaining a high school diploma.

In the year prior to the study, 78% of students enrolled at the middle school tested at a proficient level or better on the TAKS mathematics according to state standards while students classified as English language learners met standard at 63%. At the seventh grade, student proficiency level on the mathematics TAKS was 81% for the all student group and 63%, eighteen percentage points lower, for ELLs. Additionally, the campus failed to make adequate yearly progress in mathematics under the No Child Left Behind, 2000.

Context and Setting For Cross Cases Analysis Study

Beyond the need to support ELLs in school, some specific needs warrant particular attention. Historically, English language learners have not performed well in mathematics content area (National Assessment of Educational Progress, [NAEP]) and that has serious life consequences for earning potential and for participation in an increasingly technological society (Beal, Adams and Cohen, 2010).

It is important to understand the effective teaching practices and positive learning environments that support ELLs in this particular context. The prevailing view in mathematics education is that mathematics is a universal language that requires the ability to master a well-defined body of knowledge, often through repetitive practice and the ability to process abstract information (Moschkovich, 2001). Because of the emphasis on the universality of mathematics, little attention is paid to students' cultural or linguistic backgrounds (Moschkovich, 2001). The literature on effective schooling for ELLs, however, suggests that for many of these students, language and culture play important roles in learning and therefore have significant consequences for effective teaching (Moschkovich, 2001; Nasir, Hand, and Taylor, 2008).

Although English language learners (ELLs) are one of the fastest growing school-age populations in the United States (National Center for Educational Statistics [NCES], 2008), there is little evidence to suggest that they are (or will be) adequately supported while they participate in school (National Clearinghouse for English Language Acquisition, 2007). At present, the majority of teachers have had little or no professional development for teaching ELLs (NCES, 2002); few have taken a course focused on issues related to ELLs (Menken & Antunez, 2001); and most do not have the experiential knowledge that comes from being proficient in a second language (Zehler, Fleischman, and Hopstock, 2003). Furthermore, unless teachers are bilingual or are officially credentialed in bilingual education, schools provide little incentive for them to develop the skills needed to support bilingual students in their classrooms. Additionally, few teacher education programs require their students to take courses in bilingual education or Hispanic studies. And even when teachers are well credentialed in bilingual education, Spanish-speaking ELLs who receive instruction from those teachers tend to pay a price by being segregated from the mainstream curriculum and from other students.

Population and Sample

The main criterion for selecting these teachers was their willingness to participate. Three teachers: one female and two males, with a minimum of six years of teaching experience volunteered to be part of the study. In terms of descriptive information, participants in this study were similar to those in a national sample (Hill, 2007). The average number of years of experience was 17, with one individual in his first 6 years of teaching, which is slightly less than the average years of experience of 11.1 years for the campus and 10.6 years for the school district.

Teachers' career experience was similar with all three having worked at the same middle school for their entire teaching career. Of the three, two reported possessing an undergraduate mathematics minor and one possessed an undergraduate mathematics major. One participant was certified to teach high school mathematics, and two are certified to teach middle school mathematics.

All of the participants are of Hispanic ethnicity. In addition to voluntary participation, one of the teachers was included because he was considered to be an exemplary teacher in relation to teaching a reform-oriented curriculum. This was validated during data collection in that his teaching engaged students in a significant way to problem solving, communication, reasoning, and connections.

Table 6
Participants

| | Name | Gender | Ethnicity | University Degrees | Major | Minor | Teaching Certificates | Teaching Experience |
|---|-------|--------|-----------|--------------------|------------------------|-------------|-----------------------|---------------------|
| 1 | Jorge | M | Hispanic | B.S. | Electrical Engineering | Mathematics | 4-8 Mathematics | 6 years |
| 2 | María | F | Hispanic | B.A. | Elementary Education | Mathematics | 4-8 Mathematics | 25 years |
| 3 | Jesus | M | Hispanic | B.S. | Mathematics | Biology | Secondary Mathematics | 21 years |

The researcher obtained written permission from the superintendent of schools, campus principal and teachers. Once permission from the teachers was obtained (Teacher Consent Form, Appendix 6), the researcher developed a schedule for conducting in-depth, semi-structured interviews and classroom observations of the three participants. At the first meeting, the middle school teachers completed a demographic data form that provided gender, ethnicity, academic background certifications, years of teaching experience, and types and length of professional development attended (Appendix 2-6).

Data Collection

Stake (1995) and Yin (1994) identified six sources of evidence in case studies: documents, archival records, interviews, direct observation, participant-observation, and physical artifacts. The main sources of data for my study were open-ended interviews, classroom observations, surveys, academic and teaching background, and type of professional development attended, and teaching artifacts. Teacher data were collected during the fall semester of the academic year. Student achievement data were obtained from the school district student data center for the 2010–2011 school year. Lessons that were scheduled based on simple criteria (no testing days, no field trips, “regular” instruction rather than special lessons designed specifically for the study) and teacher convenience were collected from each teacher.

Interviews

Teachers participated in several interviews with the researcher. The semi-structured open-ended interviews lasted approximately an hour with each teacher and occurred during conference periods or before the school day began. The interview sessions were designed to obtain information from the participants about their practice and views of mathematics, math teaching, and the students they currently taught. The interviews included examining discussions on the participants’ emphasis on their classroom processes, planning and intentions. Interview questions were framed in both cognitive context to allow the teachers to share their way of thinking and a phenomenological context to allow them to describe their teaching behaviors as lived experiences. Some of the questions were of the form: What is the purpose of the lesson? Do you use think-aloud techniques to narrate the problem-solving processes? Do you use

informal language to increase understanding and demonstrate the various thought processes and steps to follow in solving a problem? What types of strategies do you implement to assist English language learners obtain a mathematical concept? Other questions were in the form of open situations to address success stories in helping second language learners with mathematical concepts and language acquisition. All of the participants were articulate and open about their thinking and experiences with mathematic problems particularly the difficulty of teaching mathematical concepts to second language learners.

Lesson Plan Design and Classroom Observations

The *Lesson Plan Rubric* (Appendix B) was created to rate the design of the lesson. The lesson design was rated with 9 key indicators designed to examine the effectiveness of the lesson plan including activities and types of strategies planned.

Observations were conducted on a weekly basis with the researcher visiting classrooms in forty-five minute segments during the semester. Data on the teacher behaviors within the context of the mathematic classrooms were collected through the Lesson Observation Rubric (Appendix C). To facilitate the process, the researcher met with the teacher to be observed one or two days prior to the observation for a discussion of the lesson objectives. The classroom composition: number and demographics of students, i.e., ethnicity, gender, LEP, special education services, etc., the lesson, resources, classroom structure, policy and support infrastructure, curriculum and assessment policies were collected during the initial interview, on the day of the observation, or through district data systems. Classroom observations focused on the teachers' actual instructional behaviors during lessons. Special attention was given to

what the teachers and students did during instruction and how their actions interacted during the lessons. These lessons were detailed in field notes.

The researcher used the *Lesson Observation Rubric* (Appendix C) to collect data from the classroom observations. The rubric measured the quality of an observed seventh grade mathematics classroom lesson by examining the design, implementation, mathematics content, and culture of the lesson. A journal of notes of observed teacher behaviors and characteristics, etc. were kept.

Teaching Artifacts

Teaching artifacts were collected during the conferences and on the day of the observations. The classroom artifacts consisted mainly of relevant teaching notes, lesson plans and student handouts.

Student achievement outcomes were based on the TAKS Texas Assessment of Knowledge and Skills, a state mandated test given to students in Grades 3–8. 2010-2011 was the final administration year for TAKS. The state of Texas has transitioned to the State of Texas Assessment of Academic Readiness (STAAR). The 7th Grade Mathematics TAKS is composed of a mix of multiple-choice (95%), and griddable items (5%). An inspection of the test blueprint and assessed curriculum publications posted by the Texas Education Agency (TEA) demonstrated that the items assess a mix of procedural and conceptual knowledge. The Seventh Grade Mathematics TAKS is administered in late April, roughly 4 weeks prior to the end of the school year. The scores will be used in an effort to establish a connection between mathematics teachers' background and strategies targeting English language learners in the mathematics classroom to the Texas standardized mathematics exam. Copies of the teacher lessons

and records of grades and scores obtained will be systemically analyzed and organized.

Data Analysis

Qualitative data such as interview notes, observation notes, lesson plans, teacher reflections, professional development records, and teacher certifications will be consolidated into categories. Data obtained from the interviews and forms collected will be organized and categorized. Data such as university classes, and professional development trainings will be crosschecked with district records. The principle data analyses methods for the case studies involve the nature and quality of the lessons, intellectual engagement, and nature of “sense-making,” implementation, content, and classroom culture (Nasir, Hand, and Taylor, 2008). Quantitative data such as scores on standardized exams are also to be compiled and coded. Data from the *Participant Background* (Appendix A) will be examined and compiled in a table to identify trends in the teachers’ academic backgrounds. Results of the data will be assigned numerical values and examined for trends and patterns through the use of content analysis.

The data analysis will be conducted based on the cross case studies methodologies as noted by Yin (1994, 2003) and Stake (1995, 2006). Yin (1994) posed four principals for data analysis of case studies: 1) demonstrate that the analysis relied on all the relevant evidence; 2) include all major rival interpretations in the analysis; 3) address the most significant aspect of the case study; and 4) use the researcher's prior, expert knowledge to further the analysis. Stake (1995) recommends categorical aggregation as another means of analysis and favors coding data and identifying the issues more clearly at the analysis stage. Data from the observations will be analyzed for pattern-matching (Stake, 1995 and Yin, 1994) to form a comparison with an empirical pattern and a predicted one.

Conclusion

The review of studies looked at research that addressed the following topics: English Proficiency and Mathematics Achievement, Mathematics Teacher Knowledge, Mathematics Teachers' Teaching Experience, Teacher Academic Background and Professional Development. Several studies and reports were available online on journal or organization Web sites. Studies were selected if they addressed the topics of the current study and included ELLs and/or teachers of mathematics in their samples either at the school, district, state, or federal level, and were published from respected peer-reviewed journals. The studies varied in methodologies with most having a quantitative component. The qualitative data collection methodologies included observations, field notes, questionnaires surveys, interviews, triangulation, and case studies. Most of the quantitative data centered on multiple regression, inferential statistics of tests, factor analysis, one- way analysis of variance and regression models. In many cases, studies addressed multiple themes as pertained to the current study such as pedagogy and strategies for assisting ELLs in learning mathematic concepts, the effects of teachers' academic background on the academic achievement of their students, and professional development.

The current cross case analysis study was designed to provide insight regarding the instruction of English language learners in the secondary mathematics classroom. To provide an understanding into the influences on those lessons—why particular topics and skills were taught, and why the particular instructional strategies were employed—interviews were conducted with participants before and following the observations. Additionally, teachers were provided with time to reflect on their lessons in respect to

student learn and types of strategies implemented. Archived data, such as, teacher college transcripts, and student TAKS scores will be used to make connections between teachers' academic background and student achievement.

Chapter 4 will provide the analysis and findings from the cross case analysis study of three middle school mathematics teachers. Open coding and axial coding (Strauss and Corbin, 1990), will be used to code the data collected. The data will be analyzed from a phenomenological perspective using selective coding, and thematic analysis following the techniques for case studies data analysis of Yin (2003).

CHAPTER 4: FINDINGS PART 1

The phenomenal growth of English learners in the U.S. public school system has expanded the need for public education to provide special language instruction. In the last decade, the number of English language learners in public schools increased to 5.3 million (National Clearinghouse for English Language Acquisition, 2011). This number reflects a 51% increase in the ELLs population entering U. S. public schools. In Texas the percentages are similar. Out of a Pre-K-12 enrollment of 4.6 million, over 700,000 students are ELLs, a 38.4 % increase since the 1997-1998 school year (Migrant Policy Institute, 2010). This influx of English learners has presented the education system with unique challenges of ensuring that students who are learning English language skills get the same access to the core curriculum as their mainstream peers.

At the national level, 12% of the ELL student group scored at or above proficient in mathematics at grades 4, 8, and 12 on the 2009 National Assessment of Educational Progress (NAEP) in comparison to 42 percent of non English-language learners who met proficiency standards. On the 2009 NAEP 8th grade mathematics exam, 35% of the non-ELL group was proficient while 5% of the ELLs met that standard (Slavin, Madden & Calderon, 2010). While the NAEP does not test mathematics at the 7th grade level, for purposes of this study, the 7th grade mathematics TAKS scores were reviewed. In 2011 at the state level, 81 % of the all student group met proficiency on the 7th grade mathematics TAKS with 63% of the LEP group meeting standard. At the middle school site of this study, the results of the 7th grade mathematics TAKS were similar with the all student group scoring 81% proficiency. The LEP subgroup, however, scored 68%, 5 percentage points higher than the state.

The Problem

As the number of ELLs has increased, the number of teachers trained in second language acquisition pedagogy has declined (Freeman & Crawford, 2008). Data from the 2002 National Center for Education Statistics shows that 41% of teachers have ELLs in their classes, yet fewer than 13% of those teachers have had 8 or more hours of training in second language pedagogy. The increase of ELLs in U.S. schools combined with poor performances on international, national, and state mathematics standardized tests suggest that greater attention to how mathematics content is taught to ESL students is needed (Holmes & Duron, 2000; MacDonald, 2004).

Purpose

The major purpose of this cross case analysis study is to determine the pedagogical and instructional practices of 7th grade mathematics teachers, the types of professional development 7th grade mathematics teachers need to effectively meet the needs of ELLs in the mathematics classroom, and the effects of mathematics teachers' academic backgrounds on the academic achievement of ELLs through a cross case analysis of three middle school mathematics teachers. For the purposes of this qualitative study, the following research questions were developed:

Research Question 1 What instructional practices do middle school mathematics teachers in this cross case study use in classes with ELLs? Sub-question: How do their different practices result in differential student achievement between mainstream students and ELLs?

Research Question 2 What effect does the academic background and professional development of mathematics teachers in this cross case study have on the academic achievement of their second language learners?

This chapter presents the findings obtained from lesson plans, interviews, observations implemented, and archival data. As stated in Chapter Three, this study utilized the cross-case analysis study method of analysis to construct categories and themes. Yin (1994) and Stake (1995) recommended the collection of at least six types of data for each participant; however for this study, only five forms were collected. The collection of data is depicted in Table 7 below.

Table 7
Data Collection

| Sources of Evidence (Stake, 1995 & Yin, 1994) | Case Study Evidence |
|---|---|
| Observation & Physical artifacts | 45 minute segments x 5; Lesson plans |
| Interviews & Reflections | Prior to observations; Reflection and conversations with participants |
| Archival records | <i>Student TAKS scores, personnel files—transcripts</i> |

The findings of the cross case analysis study are organized by research questions. Each case study has the following sections: lesson plans, lesson observations, professional development, teacher’s mathematics academic background, and student achievement. Teacher background is embedded in the introduction for each case study and later in the student achievement section for each participant.

Findings

In the following sections I describe the data sources for this research study. The subsections include information on how the lessons plans, the lesson observations, and classroom culture were rated. This section is followed by the three case studies.

Lesson Plans

Lessons designs were reviewed to determine the factors that distinguished lesson plans to be effective and those that were ineffective. Lessons plans were derived from CSCOPE, an online curriculum developed by the Texas Education Service Centers Curriculum Collaborative and a team of content experts from across the state of Texas. However, the participants were allowed flexibility on which lessons they selected, what activities to use, which supplemental materials to use, and how to present the lesson.

In preparation for reviewing mathematics lesson plans, I reviewed the Texas Essential Knowledge and Skills for 7th grade, the NCTM standards, taught 7th grade lessons on content attainment, cooperative learning, classifying information, and formulating and testing hypothesis, and attended several mathematics professional development sessions.

Based on the standards, I developed 10 criteria and created the *Lesson Plan Rubric* (Appendix B) to evaluate the lesson plans. The rubric examined the lesson plan based on the following measures: 1) incorporated tasks, roles, and interactions consistent with investigative mathematics; 2) reflection of careful planning and organization; 3) instructional strategies and activities used in this lesson reflected attention to students' experience, preparedness, prior knowledge, and/or learning styles; 4) resources available in this lesson as they contributed to accomplishing the purposes of the instruction; 5) instructional strategies and activities as they reflected attention to issues of access, equity, and diversity for students (e.g., cooperative learning, language-appropriate strategies/materials); 6) design of the lesson as they encouraged a collaborative approach to learning among the students; 7) adequate time and structure provided for sense-

making; 8) measurable language and content objectives as they were visible in the classroom; 9) adequate time and structure as they were provided for wrap-up; and 10) explicit listing of key vocabulary that was evident in the classroom. The rubric also included a section for listing strategies specifically targeting English language learners.

In addition, I created a 5-point scale for determining the focus of the lesson. To determine the focus of the lesson, I determined the degree the lesson concentrated on working on the development of facts/vocabulary. I then rated each key indicator in four different categories, from 1 (not at all) to 5 (to a great extent). Additional indicators will be included if considered important in capturing the essence of the lesson. Important factors that are determined to be influential in determining a synthesis ratings and specific examples and/or quotes to illustrate those factors will be indicated in the “Supporting Evidence for Synthesis Ratings”. The “Don’t know” and/or “N/A” will be used in instances when the lesson may not provide evidence for an indicator or when the indicator is inappropriate given the purpose and context of the lesson. This section also includes ratings of the likely impact of instruction and a capsule rating of the quality of the lesson instances when the lesson may not provide evidence for an indicator or when the indicator is inappropriate given the purpose and context of the lesson. Once the rating was completed, I computed the mean as to the degree that the design of the lesson reflected of best practices for teaching mathematics concepts to ELLs

Observations

The observations section of each case study includes the results of the lesson plan observations and a summary of the lessons implemented. The observations were scheduled based on simple criteria. There were no observations during testing days or

field trips. The lessons were part of the teachers' "regular" instruction rather than special lessons designed specifically for the study and teacher convenience. Observations were conducted in 45-minute segments five times during the spring semester of the school year for a total of 225 minutes per participant. Data from the observations were gathered with the *Lesson Observation Rubric* (Appendix C). During the observations I looked for characteristics of effective teaching: knowledge of subject matter, organization and clarity, teacher/student interaction, kinds and levels of questions, presentation and enthusiasm, and student behavior.

The teaching observation process involved three key stages: pre-observation, planning and discussion, the actual teaching observation, and a post-observation discussion and summary (Hammersley-Fletcher and Orsmond, 2004; Martin and Double, 1998; Millis, 1992). To prepare for and to provide some context to the teaching observation process it was important that I plan a pre-observation meeting, during which I gathered the learning objectives, key learning outcomes, and information on the participant's teaching experiences in teaching the objectives.

According to Yin (1994) interviews are one of the most important sources of case study information. For the purposes of this study, the interviews (Appendix E) were structured and participants were asked to comment about the lessons as explained below. The participants had opportunities to reflect and provide feedback about the lessons after the observations. Comments from the participants focused specifically on the lesson, such as the development, resources, etc.

Participants were interviewed prior to the observation, at a convenient time, such as a planning period or immediately before school. The interviews followed a structured

protocol. Participants were asked about the learning goals of the lesson and/or unit, the characteristics of the students in the class, and the instructional materials that were used to structure the lesson. They were also asked how well prepared they felt teaching the topic and using the particular instructional strategies employed in the lesson. In particular they were asked what type of strategies they would implement to reach their second language learners. Finally, teachers were asked about the context in which they teach, and how that context influences how and what they teach.

The *Lesson Observation Rubric* (Appendix C) was designed to rate the lessons through three components:

1. implementation, and
2. best practices for teaching English language learners (ELLs) (interwoven into the lesson implementation component).

The first component focused on the implementation of lessons, ranging from ineffective to exemplary instruction. The key indicators in the *Lesson Observation Rubric* for lesson implementation included the following: 1) instructional strategies were consistent with investigative mathematics 2) the teacher appeared confident in his/her ability to teach mathematics; 3) the teacher's classroom management style/strategies enhanced the quality of the lesson; 4) pace of the lesson was appropriate for the developmental levels/needs of the students and the purposes of the lesson; 5) teacher was able to "read" the students' level of understanding and adjusted instruction accordingly; 6) teacher, where appropriate, used models or manipulatives to demonstrate concepts and/or processes; 7) teacher's questioning strategies were likely to enhance the development of student conceptual understanding/problem solving (e.g., emphasized

higher order questions, appropriately used “wait time.” identified prior conceptions and misconceptions); 8) teacher used Think-Alouds technique to narrate the problem-solving process; 9) teacher used informal language to increase understanding and demonstrate the various thought processes and steps to follow in solving a problem; 10) teacher used clarity checks to check for understanding of the task and processes involved before students got started working on the assignment; 11) teacher presented activities that involve application problems in contextualized situations; and activities encouraged critical thinking and reasoning along with basic skills development and practice; and 12) teacher encouraged the use of diagrams and other visual aids to help students develop concepts and understanding. The indicators were rated on a score of 1 to 5 with 5 being the highest score. Once the indicators for the five lessons were rated, the mean of each indicator was computed.

The classroom culture was rated through a different rubric and included best practices for ELLs. The classroom culture was rated on key indicators ranging from ineffective to exemplary instruction. The key indicators in the *Classroom Culture Rubric* (Appendix D) included the following: 1) active participation of all was encouraged and valued; 2) there was a climate of respect for students’ ideas, questions, and contributions; 3) interactions reflected collaborative working relationships between teacher and ELLs; 4) the climate of the lesson encouraged ELLs to generate ideas, questions, conjectures, and /or propositions; 5) intellectual rigor, constructive criticism, and the challenging of ideas were evident; 6) the experiences and cultures of ELLs are valued; 7) ELLs are allowed to record answers or solution steps in their own native language; 8) focus is placed on the meanings ELLs are conveying instead of on grammar and usage; and 9)

interactions reflected collegial working relationships among students (e.g. students worked together, talked with each other about the lesson).

Observational Notes

Along with some basic descriptive information (e.g., subject, course title, and grade of the class), I documented the purpose of the lesson as described by the teacher on the lesson plan and whiteboard in the classroom and how the class time was spent, including the number of minutes spent on instructional activities as opposed to “housekeeping,” interruptions, or similar types of classroom events and the percent of instructional time spent as a whole class, in pairs/small group work, and in individual work.

Archival Data was also collected. I obtained university transcripts from personnel files. The student scores for the 2011 7th grade mathematics TAKS were attained through the district student data center. These records were used in the mathematics background and the student achievement sections of this paper.

Case Studies

The findings are presented in the case studies that follow. For each case study, I begin with a brief background to introduce the teacher. Following that, I present the findings for each of the research questions and sub-questions as related to the case study teacher.

Findings from the Jorge Case Study

The first teacher in the case study is Jorge. Certified to teach mathematics in grades 4-8, Jorge is a soft-spoken young man and has worked his entire education career at the same middle school. During the semester of the study, Jorge taught seventh-grade

mathematics and algebra 1 classes with 6 years of experience teaching mathematics at the middle school level. The mathematics class observed, 7th grade mathematics was selected because of the cluster of ELLs in that particular class. The students in Jorge's class were a mixture of 10 boys and 9 girls. Of the 19 students, 7 students were classified as ELLs.

To gain a better understanding of his perceptions of his teaching, I interviewed Jorge with pre and post interviews. The semi-structured open-ended interviews lasted approximately an hour and occurred during conference periods or before the school day began. The interview sessions were designed to obtain information from the participants about their practice and views of mathematics, math teaching, and the students they currently taught. Interview questions were framed to allow teachers to share their way of thinking and to allow them to describe their teaching behaviors as lived experiences. Some of the questions included (Appendix E): What is the purpose of the lesson? Do you use think-aloud techniques to narrate the problem-solving processes? What types of strategies do you implement to assist English language learners obtain a mathematical concept? Other questions were open ended to address success stories in helping second language learners with mathematical concepts and language acquisition.

During the interviews, Jorge often spoke of his students with respect. However, he did mention that many of his students had a defeatist view of mathematics and felt that they could not learn the concepts presented. Jorge lamented "My students often complain that mathematics is too hard and don't see a real world need for learning it." Jorge demonstrated a caring regard for his students and worried that his students would not be prepared for more challenging mathematics courses in their future.

When asked how well prepared he felt to teach the topic and to use the particular instructional strategies to reach ELLs, Jorge replied,

I am very confident in my knowledge of mathematics. What worries me is that too many of my students do not have the skills needed to succeed in this class.

Also, the LEP (limited English proficient, a term synonymous to ELLs) students have difficulty in learning the math concepts as well as the English language.

Jorge also shared his concerns regarding his proficiency in the Spanish language.

As a mathematics teacher, Jorge understood mathematics as a language unto itself; however, he felt that he might not have a full command of the mathematics academic language in Spanish. Additionally, he did not attribute his students' struggles solely on the lack of English proficiency. "Radius as opposed to *rate* of the radius. That is really hard for my students." With those remarks, Jorge suggested that the language is not the only difficulty his students faced.

In the following sections, I first introduce the research question and related sub-question, and then I provide the data from the appropriate sources: lesson plans, lesson observations, interviews, and archival data.

Research Question 1

The first research question was: *what instructional practices do middle school mathematics teachers in this cross case study use in classes with ELLs* and sub-question: *how do the different practices result in differential student achievement between mainstream students and ELLs?* To answer these questions, I report on the data I collected from Jorge's lesson plans, my observations, interviews with Jorge, and archival data in the form of student test scores.

Findings from Lesson Plans

Five lesson plans prepared by Jorge were collected for this study. The lessons were generally part of a unit as designated by the CSCOPE curriculum and planned in collaboration with the 7th grade mathematics team. The content objectives, activities for the day's lesson along with a language objective were always written on the white board and were copied onto my field notes. Also, I obtain any handouts that the students were expected to complete as part of the lesson. For this section I used the *Lesson Plan Rubric* to collect data on the lesson plans.

The CSCOPE mathematic lessons were developed as a 5 E model: engage, explore, explain, elaborate, and evaluate. While the school district had adopted CSCOPE as the main curriculum, the mathematics teachers had other resources, materials, and activities they were allowed to use, ultimately at times, the lesson plans collected were not entirely from CSCOPE, but rather developed from other sources.

The *Lesson Plan Rubric* called for a determination of the lesson focus. I rated each of the 10 key indicators using a Likert scale, from 1 (not at all) to 5 (to a great extent). Additional indicators were included if considered important in capturing the essence of the lesson. Important factors that are determined to be influential in determining a synthesis rating and specific examples and/or quotes to illustrate those factors were also included in the notes. If the lesson did not provide evidence for an indicator or when the indicator is inappropriate given the purpose and context of the lesson, I marked the "Don't know" and/or "N/A" column.

Based on the scores for the 10 key indicators in the *Lesson Plan Rubric* and the lesson focus, I determined the lessons' likely impact on student learning. The findings are

presented in Table 8. I compiled the data from the five lesson plans and rated each key indicator in five different categories, from 1 (not at all) to 5 (to a great extent).

Table 8
Lesson Plans Ratings (Jorge)

| Lesson 1=■ | Lesson 2=◆ | Lesson 3=❖ | Lesson 4=□ | Lesson 5=☆ | Not At All 1 | 2 | 3 | 4 | To Great Extent 5 | Mean |
|---|------------|------------|------------|------------|-----------------|---|---------|----|----------------------|------|
| | | | | | ←————→ | | | | | |
| | | | | | | | | | | |
| 1. The design of the lesson incorporated tasks, roles & interactions consistent with investigative mathematics. | | | | | | | ◆❖ | ■□ | | 3.6 |
| 2. The instructional strategies and activities used in this lesson reflected attention to students' experience, preparedness, prior knowledge, and/or learning styles. | | | | | ❖ | | ◆□ | ■ | □ | 3.2 |
| 3. The design of the lesson reflected careful planning and organization. | | | | | ❖ | | ◆□ | ■ | □ | 3.2 |
| 4. The resources available in this lesson contributed to accomplishing the purposes of the instruction. | | | | | | | ◆❖ | ■□ | □ | 3.6 |
| 5. The instructional strategies and activities reflected attention to issues of access, equity, and diversity for students (e.g., cooperative learning, language-appropriate strategies/materials). | | | | | ❖ | | ■◆ | | | 2.8 |
| 6. The design of the lesson encouraged a collaborative approach to learning among the students. | | | | | | | ❖□ | ■◆ | □ | 4.2 |
| 7. Adequate time and structure were provided for "sense-making. | | | | | ❖ | | ■◆ | | | 2.8 |
| 8. Measurable language and content objectives were visible in the classroom. | | | | | | | | | ■◆ ❖□ □ | 5 |
| 9. Adequate time and structure were provided for wrap-up. | | | | | ❖ | | ■◆ □ | □ | | 3 |
| 10. Explicit listing of key vocabulary was evident in the classroom. | | | | | | | | | ■◆ ❖□ □ | 5 |

The figures in Table 8 were determined by the extent to which the lesson reflected careful planning and organization, the extent to which the available resources contributed to accomplishing the purpose of the lesson, and the extent to which strategies and activities reflected attention to issues of access, equity, and diversity. To facilitate a distinction between the lessons, each is identified with a symbol. For example, lesson one is designated with a square ■; lesson 2 is labeled with a diamond ◆; lesson 3 is denoted with a dotted diamond ❖; lesson 4 is represented with a cross □; and lesson 5 is indicated by a star ☆.

Each indicator in the *Lesson Plan Rubric* is worth between 1 and 5 points times the number of lessons (5). For example for indicator 1 *the design of the lesson incorporated tasks, roles & interactions consistent with investigative mathematics*, 2 of Jorge's lesson were rated as a 3 and 3 lessons were received a 4. For this indicator, Jorge received a mean average of 3.6 ($2 \times 3 + 3 \times 4 / 5$). Indicator 2 *the instructional strategies and activities used in this lesson reflected attention to students' experience, preparedness, prior knowledge, and/or learning styles* had a mean average of 3.2 because lesson 3 did not include planning that addressed different learning styles. While other lessons had information with specific strategies such as writing to learn for ELLs, lesson 2 did not address the ELLs in the classroom. This omission affected indicator 3, *the design of the lesson reflected careful planning and organization*. In some instances, Jorge deviated from the CSCOPE curriculum and included activities that did not align with the objective of the lesson. An example of such a deviation is when he selected a TAKS review activity for an objective on measurement.

For indicator 4, *the resources available in this lesson contributed to accomplishing the purposes of the instruction*, the lessons rated a higher mean of 3.6. For example if the lesson called for one activity, Jorge had two activities ready for immediate use.

Indicator 5, *the instructional strategies and activities reflected attention to issues of access, equity, and diversity for students (e.g., cooperative learning, language-appropriate strategies/materials)* received low marks because there moderate to little attention to the learning of diverse students. The CSCOPE lessons did not always contain strategies or activities outlining how to reach special populations such as ELLs. In

reviewing the lessons developed by Jorge, I found that he did not add strategies that encouraged the learning of diverse students.

Not all the lessons actually addressed specific strategies for language learning in the classroom. Indicator 6, *the design of the lesson encouraged a collaborative approach to learning among the students*, was one of the highest rated indicator. In this area, Jorge's lessons did well because they addressed collaboration amongst the students either by asking them to work in dyads or in groups. For indicator 7 *adequate time and structure were provided for "sense-making"* the lessons had a mean of 2.8. This indicator was among the weakest elements for the lessons lacked an estimated timing for each of the activities planned. The strongest measurement was indicator 8, *measurable language and content objectives were visible in the classroom*, which was rated with a mean of 5. Each lesson always contained both language and content objectives. The ninth measure, *adequate time and structure were provided for wrap-up*, received a mean average of 3. This measure was also aligned to timing. Lesson 5 included the time allotted for all activities; however the majority addressed this indicator briefly or none at all. The last measure in the lesson design, indicator 10, *explicit listing of key vocabulary was evident in the classroom*, had a high mean of 5 for the lessons always included the vocabulary of instruction. Since there were five lessons, and five levels with 5 being the highest rating then if a lesson earned the best score, it would earn 250 points (50 points x 5 lessons=250). If the lesson earned the highest rating for all indicators, the lesson would have 250 points with a mean average of 50.

While it was noted that Jorge had a caring attitude toward his students, he had difficulty motivating his students to learn mathematics. In particular the scores in Table 7

above indicate the difficulty Jorge had in developing activities to help his students learn mathematics concepts. As a whole, Jorge's lessons earned 179 points out of 250 and had a mean of 3.5 that fell in the average section of the *Lesson Plan Rubric*.

Findings from Lesson Implementation (Observations)

Lesson implementation refers to how the teacher carried out the lesson. Indicators in implementation focus on the pace of the lesson, classroom management, teacher questioning, and the teacher's apparent confidence in teaching the subject. The extent to which the teacher's instructional strategies were consistent with investigative mathematics was also rated.

I observed five lessons for 45 minutes each. The topics of the lessons were equations, proportionality, number operations, measurement and relationships and frequency. I rated the observations using the 12 key indicators from the *Lesson Observation Rubric* (Appendix C).

For each component, I rated indicators on a scale of one to five with 1 representing an effective lesson and 5 indicating an effective lesson. Once I had a rating for each indicator, I computed the mean as presented in Table 9 below. A component of this cross-case analysis required that I analyze whether the teacher applied best practices for reaching English language learners. The *Best Practices for Teaching English Language Learners* key indicators 3, 4, 6, 7, 8, 9, 10 11, and 12 were embedded within the indicators used on the *Lesson Observation Rubric*.

Table 9
Lesson Implementation Ratings of Key Indicators (Jorge) Scale 1-5

| Lesson Implementation Ratings of Key Indicators (Jorge) Scale 1-5 | | | | | | | |
|---|------------|------------|---------------|---|-----------|------|---|
| Lesson1=■ | Lesson 2=◆ | Lesson 3=❖ | Not Effective | ↔ | Effective | Mean | |
| Lesson 4=□ | Lesson 5=□ | | | | | | |
| | | | 1 | 2 | 3 | 4 | 5 |

| | | | | | |
|--|-----|-----|------|-----|-----|
| 1. The instructional strategies were consistent with investigative mathematics | | | ■◆❖ | □ | 3.4 |
| 2. The teacher appeared confident in his/her ability to teach mathematics | | | ■◆❖ | □ □ | 5 |
| 3. The teacher's classroom management style/strategies enhanced the quality of the lesson | ■ | ◆❖□ | | | 3 |
| 4. The pace of the lesson was appropriate for the developmental levels/needs of the students and the purposes of the lesson. | ■◆ | ❖ | □ | □ | 3.2 |
| 5. The teacher was able to "read" the students' level of understanding and adjusted instruction accordingly. | ■◆ | ❖ | □ | □ | 3.2 |
| 6. The teacher, where appropriate, used models or manipulatives to demonstrate concepts and/or processes | | ■ | ◆❖□ | □ | 3.8 |
| 7. The teacher's questioning strategies were likely to enhance the development of student conceptual understanding/problem solving (e.g., emphasized higher order questions, appropriately used "wait time," identified prior conceptions and misconceptions). | ■ | ◆ | ❖□ | □ | 2.6 |
| 8. The teacher Think-Alouds technique to narrate the problem-solving process. | ■◆❖ | □ | | | 1.4 |
| 9. The teacher used informal language to increase understanding and demonstrate the various thought processes and steps to follow in solving a problem. | | ■◆❖ | □ □ | | 3.6 |
| 10. The teacher used clarity checks to check for understanding of the task and processes involved before students get started working on the assignment. | ■ | ◆❖ | □ □ | | 2.8 |
| 11. The teacher presented activities that involve application problems in contextualized situations. These activities encouraged critical thinking and reasoning along with basic skills development and practice. | | ■◆❖ | □ □ | | 3.6 |
| 12. The teacher encouraged the use of diagrams and other visual aids to help students develop concepts and understanding. | | ■◆ | ❖□ □ | | 3.6 |

Indicator 1, *the instructional strategies were consistent with investigative mathematics*, received a mean of 3.4. The lessons received high marks of either 4 or 5 because the strategies Jorge implemented were worthwhile problem-solving tasks that was centered on a theme or event and was often embedded in a focus question. An example of this was a lesson on probability, where Jorge developed an essential/guiding

question: “Does probability tell you exactly what will happen in certain situations?” as a focal point for the students. Indicator 2 *the teacher appeared confident in his/her ability to teach mathematics* received the highest mean of 5. In observing Jorge, he appeared confident in his ability to teach mathematics. Indicator 3, *the teacher’s classroom management style/strategies enhanced the quality of the lesson*, had a mean of a 3. In a lesson on proportional reasoning to solve problems, Jorge began the lesson with a warm-up and instructed students that their grade would be based on the amount of work each produced and the test taking strategies they used, such as underlining, approximation, estimating, eliminating and justifying answer choices. For indicator 4, *the pace of the lesson was appropriate for the developmental levels/needs of the students and the purposes of the lesson*, Jorge’s lesson implementation averaged a 3.2. Several lessons received 2 points for this indicator because the lessons at times seemed to be at a level above the understanding of the students. In fact, some students complained that the lesson did not follow what they had learned the previous day. Indicator 5, *the teacher was able to “read” the students’ level of understanding and adjusted instruction accordingly* also averaged mean of 3.2. This indicator related to indicator 4. On the indicator measuring active participation of all was encouraged and valued, Jorge scored low because it seemed that the same set of students were often not engaged in the lesson. In some instances, Jorge would ask the student to wake up or stay on task. The students would listen, but would revert to their original stance once the teacher moved away. The mean for indicator 6, *the teacher, where appropriate, used models or manipulatives to demonstrate concepts and/or processes*, was 3.8. Jorge implemented teaching techniques such as simplifying instructions, connecting the instruction to the ELL’s native culture,

and the use of graphic organizers to allow access of information. These hands-on activities were planned to help students understand the academic language to be learned. In this indicator Jorge received above average because he often had students using manipulatives. Jorge taught abstract, complex words that are critical to understanding the mathematics content and words that students will read, hear, and use frequently. In one lesson, he had students work with manipulatives so that students could grasp the concept of the mathematics term.

On indicator 7, *the teacher's questioning strategies were likely to enhance the development of student conceptual understanding/problem solving (e.g., emphasized higher order questions, appropriately used "wait time." identified prior conceptions and misconceptions)*, Jorge scored low, 2.6 mean, because at times, he answered the questions he posed and did not allow enough time for students to think about the question. For example, in a lesson on frequency tables, he posed the question, "What is your favorite ice cream flavor?" Before the students had an opportunity to answer (5 seconds), he started naming ice cream flavors.

Indicator 8, *the teacher think-alouds technique to narrate the problem-solving process*, was the weakest area (1.4) for Jorge. This indicator was rated low because Jorge implemented the think-aloud strategy only during lesson 5. He began the think-aloud strategy but did not use the strategy completely. Indicator 9, *the teacher used informal language to increase understanding and demonstrate the various thought processes and steps to follow in solving a problem*, was rated higher (3.6). For this indicator three lessons were rated in the mid-range and two lessons were rated above average. Often the students responded in their native tongue, Spanish. In a lesson on estimate, measurement,

and solving applications, students were engaged with foldables and were instructed to divide the paper into squares and add notes on a parallelogram. One student asked “Puedemos cortar?” While Jorge is proficient in Spanish, he answered in English “Yes,” as was mandated by the school district that mathematics classes be taught in English. On several occasions Jorge conversed in Spanish with his colleagues while standing in the hall waiting for his students, however, he never spoke Spanish in the classroom. When asked during one of the interviews, why he chose not to speak Spanish with students whose primary language he shared (Spanish-dominant students or students who preferred to work in Spanish), he responded that the campus had become a dual language campus and mathematics classes were selected to be taught in English regardless of how much English language proficiency the students had or had not acquired.

Indicator 10, *the teacher used clarity checks to check for understanding of the task and processes involved before students get started working on the assignment*, was one of the lowest rated measure (2.8). Lesson one, a lesson on measurement, scored a 2 because the activities did not connect to the objectives. The objective referenced measurement, but the activity was a TAKS practice worksheet on number lines.

Indicator 11, *the teacher presented activities that involve application problems in contextualized situations; these activities encouraged critical thinking and reasoning along with basic skills development and practice*, was rated above average (3.6). In lessons 3-5, Jorge tied the concepts to real-life contexts. For example, in the lesson on frequency tables (lesson 5) he taught the concept of frequency through the use of an ice cream manufacturing company.

Indicator 12, *the teacher encouraged the use of diagrams and other visual aids to*

help students develop concepts and understanding, was used for measuring the level of best practices for ELL learning implemented by the teacher during the lesson served to rate the lesson implementation and whether specific attention was placed on the academic needs of ELLs.

Table 8 indicates the ratings in the mid-range because instances of such practices were recorded. These strategies were aligned to indicators in the *Lesson Observation Rubric*. By preparing students with background information— such as vocabulary—at the start of a new lesson, Jorge’s students were better equipped to put that information to use. The lesson then served to reinforce new words that stand for concepts as they are learned. Aligned with strategies for teaching ELLs, Jorge generally instructed his students to manipulate the concept with discussions and written expressions. Jorge showed an understanding of his students and even displayed an interest in learning more about the specific relationship between language and learning mathematics from the point of view of his Spanish-dominant students.

Findings from Classroom Culture

While the lesson plan is important for engaging students to learn mathematics concepts, so is classroom culture conducive to learning, one that is both rigorous and respectful. To rate the culture in the classroom, I developed the *Classroom Culture Rubric* (Appendix D) with 9 criteria listed earlier. The rubric includes items that reflect best practices for ELLs. Table 10 below presents the ratings of the five lessons in Jorge’s 7th grade mathematics classroom based on these 9 indicators. The 9 indicators were developed to rate the classroom atmosphere as being conducive to learning or hindering the learning process. For each component, I rated indicators on a scale of one to five with

1 representing not effective and 5 effective. Table 10 presents the classroom culture findings for Jorge's classroom.

| Table 10 Classroom Culture Ratings of Key Indicators (Jorge) Scale 1-5 | | | | | | |
|--|------------------------------|----|---------|---------|-----|------|
| Lesson 1=■ Lesson 2=◆ Lesson 3=❖ Lesson 4=□ Lesson 5=□ | Not Effective<————>Effective | | | | | Mean |
| | 1 | 2 | 3 | 4 | 5 | |
| 2. Active participation of all was encouraged and valued | | ■◆ | ❖□ | □ | | 2 |
| 3. There was a climate of respect for students' ideas, questions, and contributions. | | | ■◆ | | ❖□□ | 4.2 |
| 4. Interactions reflected collegial working relationships among students (e.g. students worked together, talked with each other about the lesson). | | | | ■◆ ❖ | □□ | 3.8 |
| 5. Interactions reflected collaborative working relationships between teacher and ELLs. | | | ■◆ | ❖□ | □ | 3.6 |
| 6. The climate of the lesson encouraged ELLs to generate ideas, questions, conjectures, and /or propositions. | | | ■◆ | ❖□□ | | 3.6 |
| 7. Intellectual rigor, constructive criticism, and the challenging of ideas were evident. | | | ■◆ ❖ | □□ | | 3.4 |
| 8. The experiences and cultures of ELLs are valued. | | | ■◆ ❖ | □□ | | 3.4 |
| 9. ELLs are allowed to record answers or solution steps in their own native language. | | | ■◆ | ❖□□ | | 3.6 |
| 10. Focus is placed on the meanings ELLs are conveying instead of on grammar and usage. | | | ■◆ | ❖□□ | | 3.6 |

During the observations, I also recorded data for classroom culture. One of the indicators of in classroom culture is an ability to encourage and value the active participation of all students in meaningful discourse in the classroom. Indicator 1, *active participation of all was encouraged and valued*, was rated low (2) because at times, it seems that Jorge did not have the same expectations for all his students, for not all students were expected to stay on task. High expectations for student behavior are

fundamental to creating a positive, productive learning environment. While Jorge would redirect the students' behavior, the students would leave the task, as soon as Jorge turned his attention elsewhere.

Indicator 2, *there was a climate of respect for students' ideas, questions, and contributions*, was the highest rated indicator. For this indicator, lesson 1 and 2 received 3 points each, while the other three lessons received the highest points, 5. Jorge's nature itself is inviting. At one point a student asked him, "Sir why did you call my parents?" Jorge responded with "To tell them that you have improved in my classroom." "I thought you only called when I didn't do my work," replied the student. "No, I also call with the good stuff," answered Jorge. The exchange between Jorge and his student provides evidence of his caring and the friendly learning environment he has created in his classroom.

Indicator 3, *interactions reflected collegial working relationships among students (e.g. students worked together, talked with each other about the lesson)*, was rated above average with a mean of 3.8. The students in Jorge's classroom often worked with each other on the activities presented. For lesson 5 on frequency tables, Jorge began with a warm-up and instructed students that their grade would be based on the amount of work each produced and the test taking strategies they used, such as underlining, approximation, estimating, eliminating and justifying answer choices. He allowed students to work in pairs as was indicated on the language objective: "the student will write, discuss, analyze, use partner talk, class talk and group work." However, he reminded students that they had to work individually.

Indicator 4, *interactions reflected collaborative working relationships between teacher and ELLs* earned a mean of 3.6. Lesson 5 was rated the highest points because Jorge strived to connect with the ELLs in his classroom. During several lessons, Jorge worked at engaging students in meaningful activities from the first minute of class and continued to engage them throughout the lesson.

Indicator 5, *the climate of the lesson encouraged ELLs to generate ideas, questions, conjectures, and /or propositions* (3.6). There was a climate of respect for students' ideas, questions, and contributions; however, Jorge seemed to have difficulty with extending students' comments and questions to align with the lesson. Two of the lessons received 3 points while the other 3 lessons earned 4 points each. The ratings of the first two lessons brought the average down because in a lesson on proportional reasoning to solve problems, students had a difficult time understanding Jorge's questions. While Jorge asked students questions about the lesson and repeated the questions differently several times, there was little response time allocated between the questions, and students failed to respond. For the last two lessons, Jorge's had adjusted the response time allowed for students to answer questions.

Indicator 6, *intellectual rigor, constructive criticism, and the challenging of ideas were evident* (3.4). Three lessons received 3 points a piece while the last two lessons garnered five points each. During an activity on posters students had previously started on measures of central tendencies, mean, medium, mode, and range, the students were allowed to challenge each other's ideas on the posters. While the students worked, Jorge walked through the classroom and provided students with constructive comments on their work.

In a lesson on proportional reasoning to solve problems, Jorge had written the objective: apply the properties of proportionality to different units of measurement on the classroom whiteboard. Students had up to five minutes to complete the activity; however, 15 minutes elapsed and the students were still working on the warm-up activity.

Indicator 7, *the experiences and cultures of ELLs are valued*, 3.4. As the lessons proceeded and Jorge became aware of student perceptions, for example, allowing the use of a dictionary, his own approach was modified. In lesson 4, he worked with one ELL, Janie, mode and median. He included elements of direct instruction, telling, and explaining, which were much less common with his other students who he would mainly leave them with questions challenging their own thinking. Nevertheless, he praised Janie when elements of her own thinking were visible.

Indicator 8, *ELLs are allowed to record answers or solution steps in their own native language*, received 3.6 mean. This measure was rated above average because students were allowed to use their native language when computing mathematic equations. During the five observations, I recorded that students in Jorge's classroom often felt comfortable using their home language in the classroom. The native language was not only used when discussing the problems with their peers, they use the language when they worked on their own. While Jorge did not speak in Spanish to his students, he did allow them to use the Spanish language when solving mathematic equations.

Indicator 9, *focus is placed on the meanings ELLs are conveying instead of on grammar and usage*, was evaluated at a mean of 3.6. The language objective frequently directed to students to use their writing for learning mathematics concepts. When asked how he graded student writing, Jorge responded, "I look for content; so long as the

concept is apparent, I don't worry about the grammar or English usage." Through the five lessons, I noted that his students worked in pairs or groups, used manipulatives, note taking, and developed their own graphic organizers for academic vocabulary.

Although, the lessons were taken from CSCOPE and were planned with his colleagues, Jorge commented that alterations to the lessons based on the needs of his students were allowable. The instructional strategies and activities used in the lessons did reflect attention to student's experience and prior knowledge. However, there were times that the activities were not aligned to the lesson objectives. The lesson design scored at the lesson implementation and scored at the mid-range level. While the instructor attempted to engage students that were off task with their heads on the desk, working on a previous lesson, or talking to each other, the students often returned to their previous behavior once the teacher left their side and no consequences were expressed. Best practices scored in the mid-range level because there was evidence that Jorge did try to reach the ELLs in his classroom with vocabulary and other strategies designed to enhance their learning. Additionally, some of the lessons were too difficult for the students to follow. At times students seemed to be lost with the mathematics concepts presented. In a culture of achievement, students realize that the ultimate consequence of misbehavior is interrupted learning opportunities for themselves and others. At other times, it seemed that rules and consequences had not been established to delineate clear expectations for student behavior, for some students were engaged in conversations while the teacher was explaining a concept.

Findings in Teacher Mathematics Academic Background

Data for the first part of research question 2 *what effect does the academic*

background and professional development of mathematics teachers in this cross case study have on the academic achievement of second language learners was obtained through a section of the participant questionnaire, during interviews, and from archival records such as college transcripts.

Jorge was certified to teach mathematics 4-8 grades through the Alternative Certification Program. An Alternative Certification Program allows career-changers who have not studied education as undergraduate students to quickly receive provisional teacher certification while attending classes on pedagogy and teaching in their own classrooms. Prior to teaching, Jorge worked in the private sector as an electrical engineer for approximately eight years. Because he holds a degree in electrical engineering, his transcript reveals extensive coursework in high-level mathematics.

Findings in Professional Development

Desimone, Smith, and Ueno (2006) argue that professional development is at the core of school improvement efforts. Professional development is considered an essential mechanism for deepening teachers' content knowledge and developing their teaching practices. As a result, teacher professional development is a major focus of current reform initiatives (Desimone, Smith and Ueno, 2006). Recent literature on professional development has shown that high-quality professional development programs include longer contact hours; activities sustained over long periods of time; participation by teachers from the same grade, school, or subject; active learning opportunities; coherence with other reform efforts; and a focus on subject matter content (Desimone, Porter, Garet, Suk Yoon, & Birman, 2002). In particular, sustained, content-focus professional

development is associated with changes in teaching practices Desimone, Porter, et al., 2002).

To answer the second part of research question 2 *what effect does the academic background and professional development of mathematics teachers in this cross case study in this cross case study have on the academic achievement of second language learners*, I gathered the data needed through a questionnaire on professional development attended by each teacher. Additionally, I conducted interviews to gain additional information and verify what I found in the lesson plans, lesson observations, and archival data.

Based on the data in Table 11, it was evident that Jorge had attended many professional development sessions on different strategies for teaching the concepts of mathematics. During his tenure as a mathematics teacher, Jorge has attended approximately 7-12 hours of workshops that specifically addressed the needs of ELLs.

Table 11 summarizes the sessions Jorge attended.

Table 11

Professional Development Types (Jorge)

| Professional Development Session | Mathematics Content | Other | Strategies for English Language Learners |
|----------------------------------|---------------------|-------|--|
| Agile Mind | ✓ | | |
| Connected Math | ✓ | | |
| Make & Take Activities | | ✓ | |
| ELPS Math Academy | | | ✓ |
| Testing Strategies | | ✓ | |
| Instructional Strategies | | ✓ | ✓ |
| Region I Collaborative CSCOPE | ✓ | | |
| <i>Algebra I EOC</i> | ✓ | | |

| | | | |
|--|---|---|---|
| Texas Math Academy | ✓ | | |
| <i>Mathematics Series 7th Grade</i> | ✓ | | |
| <i>Professional Development Institute</i> | ✓ | | |
| CHAMPS: Conversation, Help Activity, Movement, Participation | | ✓ | ✓ |
| <i>Texas Observation Protocol (TOP)</i> | | | ✓ |
| <i>Nine Instructional Strategies</i> | | ✓ | |
| <i>Thinking Maps Middle School</i> | | ✓ | |
| <i>ELL Strategies</i> | | | ✓ |

The professional development for Jorge is slightly different than that of his colleagues because of the two preparations, 7th grade math and algebra 1. At times, he could not attend the same trainings as the other participants because of a conflict with sessions scheduled for algebra I teachers. Jorge attended 18 sessions over the last two years. The sessions were often repeated yearly with new updates. Seven of the sessions were of mathematics content nature. In these sessions, the teachers generally learned new strategies for teaching their content. Four of the professional development sessions were designed to meet the needs of the ELLs in his classroom. These sessions were designed to provide teachers with strategies for helping ELLs obtain mathematic concepts.

Findings from Student Achievement

To link student achievement to the second research question, *What effect does the academic background of mathematics teachers in this cross case study have on the academic achievement of second language learners*, I collected archival data such as student scores on the state mandated exam.

The 2011 Texas Assessment of Knowledge and Skills (TAKS) 7th grade student results were used to connect Jorge's instruction to student achievement. In reviewing the composition of the class, it was noted that most of the students in the class were not proficient on the sixth grade mathematics TAKS and 42% of the class were classified as ELLs. Table 12 below indicates the results for the class I observed in comparison to the entire grade level achievement on the 7th grade mathematics TAKS. The campus as a whole had not done as well as the previous year on the 7th grade mathematics TAKS. The difference between the ELLs and non-ELLs is apparent. The performance of Jorge's students is significantly lower than the performance of the campus all student group, with 47% passing the exam in comparison to 74% for the all student group at the campus level. The results for English language learners were more than 13 percentage points lower than the ELLs for the campus. The ELLs in Jorge's classroom met the mathematics TAKS standards with 50% substantially lower than the LEP subgroup for the 7th grade level.

Table 12
Student Demographics & Texas Assessment of Knowledge & Skills Results (Jorge)

| | Economically Disadvantaged | LEP | All Student % Met Standard | LEP % Met Standard |
|-------------------|-------------------------------|-------|----------------------------------|--------------------|
| Campus | 92.7% | 33.6% | 74% | 63% |
| Jorge's Classroom | 100% | 42% | 47% | 50% |

Conclusion

Jorge's background was different from his colleagues. Because he had come to the education field from the business world of engineering, he had not completed classes in pedagogy at the university. Additionally, the classes he had taken at the university were classes designed for a field in engineering and not the classes for mathematics

application. His lessons reflected the lack of pedagogy and at times, the activities did not align with the objectives. The lesson observations confirmed the lack of pedagogy and student teaching for he had difficulty engaging all students.

Part 2 of the findings will continue in Chapter 5. In Chapter 5, I will present the findings for the lesson, lesson observation, best practices for teaching ELLs, classroom culture, mathematics academic background, professional development and student achievement for the second and third case studies. The two additional case studies will be followed by a cross-case analysis.

Chapter 5 Findings Part II

Chapter 5 continues with the findings for the second and third case studies. The findings for the sections: lesson plans, lesson observations, classroom culture, mathematics academic background, professional development, and student achievement for the second and third case studies are included in this chapter. The two additional case studies are followed by a cross-case analysis.

María: Case Study 2

María, a petite woman in her forties, is the second case study. On paper she does not appear to be particularly well prepared to teach middle school mathematics. Although she has twenty-six years of teaching experience, she is a generalist with a degree in elementary education and a minor in mathematics. She is certified to teach 4-8 grade mathematics and currently teaches 7th grade mathematics. Like many elementary-certified teachers she does not have a degree in mathematics. The enrollment in María's classroom was 22 students of which 10 were male and 5 were classified as ELLs.

During the initial interview, María pointed out that she had not originally intended to be a mathematics teacher, and said: "I did not study to become a mathematics teacher in college; I thought I was going to become an elementary teacher." María did not teach at an elementary campus; rather, she obtained certification that allowed her to teach mathematics at the middle school level.

While María was confident in her approach to teaching mathematics, she often worried about the ELLs in her classroom. At one point María commented, "We are told that we are not to use the Spanish language in the mathematics classroom, but how am I expected to teach students who do not know English?"

Despite her concerns, María cared for her students and wanted them to succeed. A point of contention for María was the administration at the campus. “The administrators at this campus believe they know what the students need and often ask us to use strategies that are not necessarily the best for teaching the concepts of mathematics, so we use the strategies and then the next year they change them.”

Findings from the María Case Study

The presentation of the findings is organized around the research questions and sub-questions. For each, I provide the data from the appropriate sources: lesson plans, lesson observations, interviews, and archival data.

Research Question 1

The first research question was: *what instructional practices do middle school mathematics teachers in this cross case study use in classes with ELLs and sub-question: how do the different practices result in differential student achievement between mainstream students and ELLs?* To answer these questions, I gathered data from María’s lesson plans, observations, interviews with María, and archival data.

Findings from Lesson Plans

Like Jorge, María followed the district-selected *CSCOPE* curriculum. The *CSCOPE* mathematics lessons were developed based on the National Council for Mathematics Teachers (NCTM), mathematics standards and the State of Texas Essential Knowledge and Skills (TEKS). Both set of standards focus on intuitive, exploratory investigations that use informal reasoning to help students develop a strong conceptual basis that leads to greater mathematical abstraction.

María’s assignment was the same throughout the day. She taught 7th grade

mathematics five times a day. Like her colleagues, she worked with the CSCOPE lessons but supplemented the lessons with other activities from resources and materials she had obtained throughout her years of teaching.

To rate the lesson plans, I used the *Lesson Plan Rubric* (Appendix B) described in Chapter 4. The *Lesson Plan Rubric* was designed to assess the quality of lessons in relation to effective mathematics instruction and the degree the plan worked on the development of processes/facts/vocabulary. The data compiled were from 5 lesson plans developed by María. The lessons, planned in collaboration with the 7th grade mathematics team, were generally part of a unit as designated by the CSCOPE curriculum. The content objectives, activities for the day's lesson along with a language objective were written on the lesson plans as well as on the classroom white board. Handouts that the students were expected to complete as part of the lesson were also collected.

Table 13 depicts the rating of the 5 lesson plans. In addition to the 10 indicators, the *Lesson Plan Rubric* (Appendix B) called for a determination of the degree the lesson devoted to the development of processes/facts/vocabulary. I rated each of the 10 key indicators using a 1 (not at all) to 5 (to a great extent) scale.

The findings for the lesson plans ratings are presented in Table 13. I compiled the data from the five lesson plans and rated each key indicator for 5 levels. Important factors that were determined to be influential in determining a synthesis ratings and specific examples and/or quotes to illustrate those factors were indicated. In making the final determination, I also considered whether the degree of “sense-making” of mathematics content within the lessons was appropriate for the developmental needs of the students and the purposes of the lessons.

Table 13
Lesson Plans Ratings (María)

| Lesson 1=■ Lesson 4=□ | Lesson 2=◆ | Lesson 3=❖ Lesson 5=□ | <div style="display: flex; align-items: center; justify-content: space-between;"> Not At All ←————→ To Great Extent </div> | | | | | Mean |
|---|------------|--------------------------|---|---|---|-------|-------|------|
| | | | 1 | 2 | 3 | 4 | 5 | |
| 1. The design of the lesson incorporated tasks, roles & interactions consistent with investigative mathematics. | | | | | ■ | ◆❖□ | □ | 4 |
| 2. The instructional strategies and activities used in this lesson reflected attention to students' experience, preparedness, prior knowledge, and/or learning styles. | | | | | | ■◆❖□ | □ | 4.2 |
| 3. The design of the lesson reflected careful planning and organization. | | | | | | ■◆❖□ | □ | 4.2 |
| 4. The resources available in this lesson contributed to accomplishing the purposes of the instruction. | | | | | ■ | ◆❖□□ | | 3.8 |
| 5. The instructional strategies and activities reflected attention to issues of access, equity, and diversity for students (e.g., cooperative learning, language-appropriate strategies/materials). | | | | ◆ | | ■❖□□ | | 3.8 |
| 6. The design of the lesson encouraged a collaborative approach to learning among the students. | | | | | | ■◆❖□□ | | 4 |
| 7. Adequate time and structure were provided for "sense-making. | | | | | | ■◆❖□ | | 4 |
| 8. Measurable language and content objectives were visible in the classroom. | | | | | | | ■◆❖□□ | 5 |
| 9. Adequate time and structure were provided for wrap-up. | | | | | | ■◆❖□ | □ | 4.2 |
| 10. Explicit listing of key vocabulary was evident in the classroom. | | | | | | ■◆❖□□ | | 4 |

María's lessons were generally rated at the high end of the scale, for most of her lesson plans were structured and implemented so that students were engaged and likely to enhance their knowledge of mathematics concepts. All lessons included a clear intent for learning, had student-focused opportunities, real-life applications, and made mathematics meaningful.

Indicator 1, *the design of the lesson incorporated tasks, roles & interactions consistent with investigative mathematics*, was rated at the higher end of the scale. Her beliefs for teaching mathematics echoed those of Jesus, Case Study 3. "Students need to see the applications of mathematics within the classroom to be better prepared outside of the classroom," stated María. She believed that mathematics should be set in a realistic

content and that developing thinking and problem-solving skills is critical. In lesson 4, she orchestrated several methods for solving a problem on the cost of balloons.

Indicator 2, *the instructional strategies and activities used in this lesson reflected attention to students' experience, preparedness, prior knowledge, and/or learning styles*, was given a 4.2 rating. Lessons 1-4 yielded 4 points while lesson 5 earned 5 points. María believed that students could learn but lamented the fact that too often the 6th grade teachers did not prepare the students for 7th grade mathematics. "They come to us without the basics, so for the first six-weeks, I have to spend quite a bit of time working with concepts they should have learned the previous year." In one of her lesson plans, María had written the following note: *assess students' prior knowledge by asking questions and listing the responses on an overhead transparency*.

The mean for indicator 3, *the design of the lesson reflected careful planning and organization*, was 4.2. In reading the lesson plans, it became apparent that María was cognizant that careful planning of activities is a significant contributor to achieving student learning. Brown (2006) emphasizes that student needs are "central to the planning process." In practice, this means that the planning and design process for a given session starts with an identification of the student learning outcomes for the session. The other processes then proceed backwards from the outcomes.

Indicator 4, *the resources available in this lesson contributed to accomplishing the purposes of the instruction*, was rated at 3.8 because lesson 1 received 3 points. For that lesson, María did not have enough handouts for all her students. However, the resources for the other lessons were available on a table in the corner of the room. At the table, María not only had activities, she also had manipulatives, colors, scissors, tape,

geometric shapes, and boards that she used with the lessons.

Indicator 5, *the instructional strategies and activities reflected attention to issues of access, equity, and diversity for students (e.g., cooperative learning, language-appropriate strategies/materials)*, also received a mean of 3.8. In lesson 1 on setting up equations, she took her student through a problem using a think-aloud technique. By verbalizing her inner speech (silent dialogue) as she thought her way through a problem, María modeled how expert thinkers solve problems. As she reflected on her learning processes, she discussed with students the problems learners face and how learners try to solve them. As students think out loud with their teacher and with one another, they gradually internalize this dialogue; it becomes their inner speech, the means by which they direct their own behaviors and problem-solving processes.

Indicator 6, *the design of the lesson encouraged a collaborative approach to learning among the students*, and indicator 7, *adequate time and structure were provided for “sense-making*, received a mean of 4. All lessons for both of these indicators earned 4 points each. While María did not always use cooperative seating for her students, she had established a math buddy system. For example, in the lesson on probabilities (casino activity), she had the students work in pairs with each student taking a role in the process of the activity. She also provided time for students to make sense of what they were working on. In a lesson on fractions, she allowed students to work with their math buddy and discuss the processes they had used to obtain an answer.

Indicator 8, *measurable language and content objectives were visible in the classroom*, received a perfect score of 5. While the language and content objectives were written on the lesson plans, they were also written on the classroom whiteboard.

Additionally, María reviewed the objectives for both language and content with the students at the beginning of the lesson.

Indicator 9, *adequate time and structure were provided for wrap-up*, received a 4.2 mean. For most of the lessons, María afforded her students enough time for them to synthesize the concept or to ask questions. At the end of the lesson, María wrapped-up the lesson with a five-minute review of what the students had learned or with students themselves presenting what they had learned. In a lesson on complex fractions, she waited patiently until all her students had completed the assignment before discussing the processes and answers of the assignment. In a lesson on probability (casino example), she had the students report their findings once they had completed the activity.

Explicit listing of key vocabulary was evident in the classroom, indicator 10, had a mean of 4. A review of the lesson plans indicated that María was cognizant of her ELLs' needs in learning a language and content simultaneously. In the side notes of the lesson plans, María often wrote the English academic language along with the Spanish version of the word. For example, lesson 3 on fractions she had written the term to *fracción* when a student asked for clarification.

The lessons rated high on the scale of 1 to 5 because they were organized and detailed according to the lesson and language objectives. All 5 lessons were focused around generalizations and followed with activities that were aligned to the objectives.

Findings from Lesson Observations

In María's classroom, problems often incorporated recently acquired skills or were an introduction to a new set of skills to be learned in a necessary circumstance. Such experiences conform to the definition of problem solving offered by Ginsberg,

Lopez, Mukhopadhyay, Yamamoto, Willis, & Kelly (1992) as being active, conjecturing, modeling, and applying skills.

Data from the lesson implementation was gathered through the *Lesson Observation Rubric* (Appendix C) that was described in Chapter 4. The *Lesson Observation rubric* contained 12 key indicators. In addition, I created a 5-point scale for determining the focus of the lesson.

To determine the focus of the lesson, I determined the degree the lesson concentrated on working on the development of facts/vocabulary. I then rated each key indicator in five different categories, from 1 (not at all) to 5 (to a great extent). Once the rating was completed, I computed the mean as to the degree that the design of the lesson reflected of best practices for teaching mathematics concepts to ELLs.

Table 14
Lesson Implementation Ratings of Key Indicators (María) Scale 1-5

| | Lesson 1=■ Lesson 2=◆ Lesson 3=❖ Lesson 4=□ Lesson 5=□ | | | | | Mean |
|--|--|---|---|------|-------|------|
| | 1 | 2 | 3 | 4 | 5 | |
| 1. The instructional strategies were consistent with investigative mathematics | | | | ■◆❖ | □□ | 4.4 |
| 2. The teacher appeared confident in his/her ability to teach mathematics | | | | | ■◆❖□□ | 5 |
| 3. The teacher's classroom management style/strategies enhanced the quality of the lesson | | | | ■❖ | ◆□□ | 4.6 |
| 4. The pace of the lesson was appropriate for the developmental levels/needs of the students and the purposes of the lesson. | | | | ■◆❖ | □□ | 4.4 |
| 5. The teacher was able to "read" the students' level of understanding and adjusted instruction accordingly. | | | | ■◆❖□ | □ | 4.2 |
| 6. The teacher, where appropriate, used models or manipulatives to demonstrate concepts and/or processes | | | | ■◆❖□ | □ | 4.2 |
| 7. The teacher's questioning strategies were likely to enhance the development of student conceptual understanding/problem solving (e.g., emphasized higher order questions, appropriately used "wait time," identified prior conceptions and misconceptions). | | | | ■◆❖□ | □ | 4.2 |

| | | |
|--|------------|-----|
| 8. The teacher used think-alouds technique to narrate the problem-solving process. | ◆◆■ □ □ | 5 |
| 9. The teacher used informal language to increase understanding and demonstrate the various thought processes and steps to follow in solving a problem. | ■◆◆ □ | 4.2 |
| 10. The teacher used clarity checks to check for understanding of the task and processes involved before students get started working on the assignment. | ■◆◆ □ | 4.2 |
| 11. The teacher presented activities that involve application problems in contextualized situations. These activities encouraged critical thinking and reasoning along with basic skills development and practice. | ■◆◆ □ | 4.2 |
| 12. The teacher encouraged the use of diagrams and other visual aids to help students develop concepts and understanding. | ■◆◆ □ | 4.2 |

Table 14 above presents the mean of each indicator on the *Lesson Implementation Rubric* for María. Indicator 1, *the instructional strategies were consistent with investigative mathematics*, earned a mean of 4.4. While, I only observed five lessons, conversations with it María indicated that she was cognizant of the four main areas of emphasis in grade 7: proportional relationships and applying those relationships to solve problems; operations with rational numbers; expressions and linear equations; scale drawings and informal geometric constructions; attributes of circles; and drawing inferences about populations based on samples and concepts of chance. In a lesson on fractions she walked the students through the following problem:

$$\begin{aligned} \text{Complexity} &= 5, \text{ Mode} = \text{fraction} \\ \text{Solve for } n \\ 24/40 &= n/50 \end{aligned}$$

Indicator 2, *the teacher appeared confident in his/her ability to teach mathematics instructional strategies were consistent with investigative mathematics*, earned a mean of 5. María's lessons generally began with a brief discussion of the terms that were to be used in the lesson. Lesson 5, probability (casino activity) was connected the lesson to the

previous night's homework. Additionally, María often modeled how to perform specific skills or procedures and had students draw pictures or used sentence stems to help ELLs during class discussions: *Each of these problems has*_____.
The strategy I used to solve this problem was _____. *Another way I could solve this problem is* _____.

For indicator 3, *the teacher's classroom management style/strategies enhanced the quality of the lesson*, María earned a mean of 4.6. Throughout the five lessons that I observed, María was always cognizant of the entire classroom. While she worked with one student at a time, she kept the rest of the class on task by reminding them to use their reading and listening skills when working with their math buddy. It was evident that María had a clear idea of what was expected from the students and the students had a clear idea of what she expected from them. During lesson 3, one student complained that his math buddy was asleep. Within a few seconds, María was by the student's side and redirected the behavior to the task. The student immediately sat up and began working with his partner.

Indicator 4, *the pace of the lesson was appropriate for the developmental levels/needs of the students and the purposes of the lesson*, earned a mean of 4.4. María scored fairly high because of the strategies implemented during the observations. María was cognizant of the ELLs in her classroom and often met their academic needs with different strategies. In lesson 3 on fractions, she provided direct translations of cognates such as *fracción* for fraction.

Indicator 5, *the teacher was able to "read" the students' level of understanding and adjusted instruction accordingly*, earned a mean of 4.2. During a discussion on

classroom and district assessments María commented that she often reviewed data from the exam before returning the exam to the students. María used the data to identify content area and skills that needed reinforcement and factors that may motivate student learning.

Indicator 6, the teacher, *where appropriate, used models or manipulatives to demonstrate concepts and/or processes*, earned a mean of 4.2. María scored fairly high in lesson implementation because the lessons were almost always connected to a previous lesson and vocabulary was always introduced, reviewed, or reinforced prior to the students using the concepts to solve problems. María often implemented manipulatives that students moved and manipulated to support their thinking and learning. In lesson 2 on geometric shapes and fractions, she had students use colored linking cubes for building patterns. In lesson 1 she had the words written on sentence strips with the definition on the back. The students holding the words were not allowed to verbalize any hints, instead they acted out the word until the other students provided the correct definition.

For indicator 7, *the teacher's questioning strategies were likely to enhance the development of student conceptual understanding/problem solving (e.g., emphasized higher order questions, appropriately used "wait time" identified prior conceptions and misconceptions)*, María received a 4.2 mean. All 5 lessons received high marks in this measure because she often used open-ended questions as a focus for the lesson. For lesson 5 on probabilities, María opened with several questions: *What things could happen in this experiment? What is the probability that this event* (for example: rolling a 3 on a number cube) *happens?* This line of questioning continued throughout the entire lesson.

The wait time for students to answer was appropriate for students did answer her questions as a group.

Indicator 8, *the teacher think-alouds technique to narrate the problem-solving process*, earned a mean of 5. María often implemented a think-alouds technique to narrate the problem-solving process. In a review activity on numbers, operation, and quantitative reasoning, she used the think-aloud strategy while talking through how to read and solve the following mathematics problem:

Sara saved \$12.85 from her allowance. At the beach, she spent \$1.75 for an ice cream cone and \$4.50 in the video arcade. She wants to buy a necklace that costs \$5.00. Does she have enough money left to buy the necklace?

María began by reading the problem and speaking to herself: “What do they want me to find out? Hmmm...Does Sara have enough money to buy the necklace? How much does she need for the necklace? \$5.00. I’ll write that down here. Ok, she needs \$5.00. How much did she start out with? Oh, \$12.85. Well, she had enough to start out with, but she spent some of it. How much did she spend? She bought an ice cream cone for \$1.75, and she spent \$4.50 in the arcade. What do I do now? I guess there are two ways I could do this. I could subtract one amount from \$12.85 and the other amount from what she had left, or I could add both of the amounts she spent and then subtract the total from \$12.85.” In this example, María worked out the problem using two different methods to show that the answer is the same and demonstrated the thought process of checking for the reasonableness of her answer. She continued the same process and demonstrated other similar problems before providing students with an opportunity to work some problems of their own.

The mean of 4.2 was totaled for indicator 9, *the teacher used informal language to increase understanding and demonstrate the various thought processes and steps to follow in solving a problem*. In more than one lesson, María defined a vocabulary word with a synonym. For example, when reading a problem, she stated, “The term in the problem has the word *exactly* that can also mean *only*.” In another instance, she asked students to define *mean*, *median*, and *mode*. When students hesitated, she reminded them that they had completed a vocabulary exercise the day before and instructed them to review their notes from the previous day. The students immediately searched their notebooks and responded appropriately. María explained how the term *mean* was the same as *average*. She reinforced the definition by providing an example: the batting average for baseball players, the average grade in the class, the average age of students in her mathematics class. In reinforcing academic language and teaching students to solve problems with different methods, she built background knowledge by connecting what students already knew about a topic to new skills and concepts.

Indicator 10, *the teacher used clarity checks to check for understanding of the task and processes involved before students get started working on the assignment*, earned a mean of 4.2. During lesson 4, María, displayed a transparency on probability problems and led a class discussion using the student responses. In the discussion, María asked questions such as: *How did you determine the sample space for this experiment? The sample space is the table you are working with. How did you determine the probability? Another word for probability is the odds. An example is when you buy a lottery ticket. You are playing the odds of winning. That is why not everyone wins*. To make connections with the real world, María led a discussion with the students

comparing the experiment they conducted to the casinos in Las Vegas.

Indicator 11, *the teacher presented activities that involve application problems in contextualized situations; these activities encouraged critical thinking and reasoning along with basic skills development and practice* earned a mean of 4.2. In lesson 4, students were engaged in a lively discussion of a frequency table in which they were using a die to find the odds in a casino game. This lesson was an extension of an experiment they had conducted the previous day. María presented a lesson on formulating and testing hypotheses, also known as probability, as an extension to a homework assignment. As the students worked, María monitored student progress and facilitated student discussion and posed the hypothesis: *What are the odds of rolling a sum of twelve with a set of dice?* The students worked in pairs and created a table of their findings. To help the students with the tables, she continuously posed the questions: *Why do we consider rolling a 1 on the fair-sided number cube a single experiment?* To this the students answered, “Because we only recorded one thing.” *Would the experiment of rolling two fair number cubes be considered a simple experiment or a composite experiment?* “Composite.”

The mean of 4.2 was scored for indicator 12 *the teacher encouraged the use of diagrams and other visual aids to help students develop concepts and understanding*. In lesson 3 María taught students how to solve a problem through different methods, writing examples as she spoke. María wrote the steps of the problems on a transparency on the overhead projector and connected a think aloud.

Party balloons cost \$15.00 for four balloons. How much will Mary spend on balloons if she buys a dozen balloons? Show your work.

“First I need to set up an equation $4/15 = 12/x$. In this equation the 4 represents four

balloons and 15 the amount for 4 balloons; 12 represents the number of balloons Mary will buy and x is the cost we are solving for.” “In a more simplistic method you can list the number of balloons, and the cost of the balloons and add.”

$$\begin{array}{r} 4 \text{ balloons} = \$15.00 \\ 4 \text{ balloons} = \$15.00 \\ 4 \text{ balloons} = \$15.00 \\ \hline 12 \text{ balloons} = \$45.00 \end{array}$$

The 5 lessons were rated on the upper end of the scale because of María's attention to the objectives and alignment of activities and resources. While the lessons implemented were difficult at times, they were engaging and captured the students' attention. At times, she even translated problems to assist ELLs in learning the concepts.

Findings from Classroom Culture

María's positive and engaging classroom culture was evident every time I walked into the classroom. The objectives of the lesson were posted on the white board, so that students and others that entered the classroom knew immediately what was expected for the day. Classroom rules were also visible to all who entered the classroom. The classroom was structured in rows with an overhead projector and Promethium Board at the front of the classroom and the teacher's desk in the back of the classroom. Students' work and a word wall decorated the classroom walls, and models hung from the ceiling. While the classroom setting was traditional, María favored using the buddy system instead of moving desks around the room. Often students were instructed to turn to their math buddy behind them to work on a specific problem. María had developed a supportive, learning environment to engage her students in mathematics.

The classroom culture was rated using the *Classroom Culture Rubric* (Appendix D). Table 15 shows the rating on this rubric for María's lessons. This rubric includes classroom culture considerations for ELLs.

Table 15
Classroom Culture Ratings of Key Indicators (María) Scale 1-5

| Lesson 1=■ Lesson 2=◆ Lesson 3=❖ Lesson 4=□ Lesson 5=□ | | | Not Effective ← → Effective | | | | | Mean |
|---|---|--|-----------------------------|---|---|---------|----|------|
| | | | 1 | 2 | 3 | 4 | 5 | |
| 1. | Active participation of all was encouraged and valued | | | | | ■◆ ❖ | □□ | 4.4 |
| 2. | There was a climate of respect for students' ideas, questions, and contributions. | | | | | ■◆ ❖ | □□ | 4.4 |
| 3. | Interactions reflected collegial working relationships among students (e.g. students worked together, talked with each other about the lesson). | | | | | ■◆ ❖ | □□ | 4.4 |
| 4. | Interactions reflected collaborative working relationships between teacher and ELLs. | | | | | ■◆ ❖ | □□ | 4.4 |
| 5. | The climate of the lesson encouraged ELLs to generate ideas, questions, conjectures, and /or propositions. | | | | | ■◆ ❖ | □□ | 4.4 |
| 6. | Intellectual rigor, constructive criticism, and the challenging of ideas were evident. | | | | | ■◆ ❖ | □□ | 4.4 |
| 7. | The experiences and cultures of ELLs are valued. | | | | | ■◆ ❖ | □□ | 4.4 |
| 8. | ELLs are allowed to record answers or solution steps in their own native language. | | | | | ■◆ ❖ | □□ | 4.4 |
| 9. | Focus is placed on the meanings ELLs are conveying instead of on grammar and usage. | | | | | ■◆ ❖ | □□ | 4.4 |

Indicator 1, *active participation of all was encouraged and valued* was given a 4.4 mean. Classroom culture was also rated high because there was an encouragement of active participation of all in the activities of the day. During a lesson on fractions, all students were racing to be the first to solve the following equations:

Complexity=3, Mode=improper
Subtract each pair of fractions and simplify the result.
 $3/2 - 1/2$ and $4/5 - 1/3$

María had promised the students that if all participated in solving the equations, she would allow them to read during the last 5 minutes of the class period.

Indicator 2 *there was a climate of respect for students' ideas, questions, and contributions* resulted in a 4.2 mean. María established a climate that encouraged all students as well as ELLs to generate ideas, questions, conjectures, and /or propositions. In a lesson on fractions, the students were to work in pairs, complete the equations, and then present their findings to the group. María established the rules by announcing that no one was to laugh if a group had the wrong answer. Instead students were to help the pair obtain the correct answer with constructive comments.

Indicator 3 *interactions reflected collegial working relationships among students (e.g. students worked together, talked with each other about the lesson)*, receive a mean of 4.4. While the students generally set at desk in row formations, María generally had the students working with their math buddies. Lesson 4 on probabilities called for two students to work together and the lesson on fractions also called for students to work together. Additionally, students knew that they were to respect each other's work.

Indicator 4 *interactions reflected collaborative working relationships between teacher and ELLs*, received a mean of 4.4. In one lesson she applied a think-aloud procedure as a step in preparing for understanding the problem-solving steps. Additionally, she employed teacher modeling of a strategy for an activity on fractions: "First, I need to [factor the numerator with the denominator to the lowest number, next, I need to [verify that both fractions are equal], finally, I need to [start the next fraction and

complete the steps].” María applied strategies so that all her students learned the mathematics concepts and ensured that her ELLs learned as well as all native English speakers.

In line with the other indicators, indicator 5, *the climate of the lesson encouraged ELLs to generate ideas, questions, conjectures, and /or propositions*, earned a 4.2 mean. María often implemented multiple strategies designed to assist her students in learning mathematics concepts. At times, María used a traditional approach of giving examples at the whiteboard, after which students practiced the skill. Other times, she engaged students in active problem solving that focused on developing mathematical understanding, presenting mathematics in context, and encouraging communication about mathematics.

Indicator 6, *intellectual rigor, constructive criticism, and the challenging of ideas were evident*, had a mean of 4.4. María encouraged her students to investigate the problem and to determine and present a solution. While discussing a word problem, María asked one student to interpret a problem and then another student to rephrase the problem in his own words.

Indicator 7, *the experiences and cultures of ELLs are valued*, earned a 4.4 mean. María was empathetic of her students’ lack of English proficiency. She worked at helping them develop academic language as often as she could. In a lesson on geometric solids, she had the students find examples in their every days lives and from around their house. To facilitate the process, she also had magazines and newspapers in the classroom as resources for finding additional shapes.

Indicator 8, *ELLs are allowed to record answers or solution steps in their own*

native language, scored 4.4. During two lesson implementations, María had established a positive classroom environment, had students paraphrase directions, ensured that all students were engaged in the lesson, varied who she called on and was aware of her teaching tempo. These lessons were rated high because of the methods in which María presented the content to the students. María introduced the purpose of the lessons and related the objective to the students' lives.

Indicator 9, *focus is placed on the meanings ELLs are conveying instead of on grammar and usage*, also garnered a 4.2 mean. Similar to case study 1, María often implemented writing as part of the language objective. In a lesson on probabilities, María instructed her students to write a paragraph on the probabilities of their football team winning a football game during the season based on their winnings the previous year.

María received high marks because the lessons were well organized and activities aligned with the objectives. She also implemented teacher think-alouds; used informal language to increase understanding and demonstrate the various thought processes and steps to follow in solving a problem; and used clarity checks to check for understanding of the task and processes involved before students get started working on the assignment.

Research Question 2

Data for the first part of the second research question *what effect does the academic background and professional development of mathematics teachers in this cross case study have on the academic achievement of second language learners*, was obtained through a section of the participant questionnaire and archival records such as college transcripts.

Findings in Teacher Mathematics Academic Background

Teacher knowledge has long been the subject of intense research. Schulman (1986) emphasizes knowledge of multiple ways of representing the content to students. Such knowledge has as its purpose the transformation of that content into a form that students will understand. Within this idea, Schulman (1986) includes “illustrations, examples, explanations and demonstrations” (p. 9). A review of María’s transcript revealed a major in elementary education with a minor in mathematics. Unlike her colleagues, the majority of her coursework was in general elementary classes and she had earned twelve credit hours in upper level mathematics classes. However, she had taught middle school mathematics for 26 years. As an experienced teacher, María recognized the importance of students learning how to perform mathematical algorithms such as solving quadratic equations or using matrices to solve linear equations.

To María, it was especially important that students be able to take a realistic problem and interpret it in such a way that they could build a mathematical model to solve the problem. To support her students in learning, María often used diagrams or concrete materials such as a pie, number line, or cutting up a piece of paper. During an interview, she provided an example of how difficult fractions can be for middle school students. In a specific problem on fractions she demonstrated that when $\frac{4}{10}$ is added to $\frac{7}{10}$, the result is more than a whole, so students are generally confused. Instead, she suggested showing the students that $\frac{3}{10}$ must be added to make a whole with $\frac{7}{10}$ and emphasized helping students to understand the effect of the denominator on the size of the pieces.

Although math was not her major, María was confident in her content knowledge.

Students were repeatedly presented with open-ended problems, given in a realistic context. María stressed the importance of students' reading skills and had the students practice with each other, taking turns reading the problem until they understood what the problem was asking. María would consistently remind her students, "As a student, you need to read the problem carefully and interpret what it is asking you to do. Here in the classroom, I can help you, but I will not be there during your state exam."

María admittedly was not as proficient in the use of technology as she wanted to be and used an overhead projector for most of her lessons. "I am not as proficient with technology and have not mastered the Promethium Board, but I know my students' needs."

Findings from Professional Development

To answer the second part of research question 2 *what effect does the academic background and professional development of mathematics teachers in this cross case study have on the academic achievement of second language learners*, I gathered the data needed through a questionnaire on professional development attended by each teacher. Additionally, I conducted interviews to gain additional information and verify what I found in the lesson plans, lesson observations, and archival data.

With twenty-six years in education, it was of no surprise that María completed the background sheet quite quickly. The district where she and her colleagues taught was known for providing extensive professional development throughout the school year and during the summer months. Over her years in service, María had attended many professional development sessions on different strategies for teaching the concepts of mathematics. However, she also shared concerns on the lack of specific strategies for

teaching math concepts to English language learners, particular students who were enrolled in U.S. schools for the first time. Like her colleagues, María attended approximately 7-12 hours of workshops per year that specifically addressed the needs of ELLs.

The professional development sessions María attended are summarized in Table 16. María listed 16 sessions of which 5 were directly related to mathematics content. While María had attended professional development workshops designed to help her assist second language learners, she worried that she did not have the preparation to provide high-quality instruction to this population of students. Hence, she often used Spanish in her classroom to help her students learn the mathematics concepts in English.

Table 16
Professional Development Types (María)

| Professional Development Session | Mathematics Content | Other | Strategies for English Language Learners |
|---|---------------------|-------|--|
| Connected Math | ✓ | | |
| Ignite Learning Program: Math for MS Teachers | ✓ | ✓ | |
| Testing Strategies | | | |
| Instructional Strategies | | ✓ | ✓ |
| Region I Collaborative CSCOPE | ✓ | | |
| Cooperative Learning Strategies | | ✓ | ✓ |
| ELPS Math Academy | | | ✓ |
| Texas Math Academy | ✓ | | |
| ESL Institute for Secondary Teachers-Experienced | | | ✓ |
| Co-Teaching and Strategies to Meet the Needs of Diverse Exceptional Learner | | | ✓ |
| CHAMPS: Conversation, Help Activity, Movement, Participation | ✓ | | ✓ |

Write to Learn

✓

✓

Findings from Student Achievement

The results from the 2011 Texas Assessment of Knowledge and Skills (TAKS) 7th grade were used to associate María's instruction and student achievement and to answer research question 3: *what effect does the academic background of mathematics teachers in this cross case study have on the academic achievement of second language learners?* Like Jorge's classroom, most of the students in María's classroom had not met proficiency level on the sixth grade mathematics TAKS.

The student demographics and the proficiency percentages on the 7th grade mathematics TAKS for the class I observed are depicted in Table 17 below. All of the students in María's classroom came from economically disadvantaged families. The number of LEP students in María's classroom was 7 percentage points lower than the campus LEP student group average. In meeting the proficiency standards on the 7th grade TAKS, María's students scored 21 points below the 7th grade student group for the campus. The proficiency rate for ELLs in María's classroom was similar to Jorge's classroom. Only one of the ELLs in María's classroom met proficiency levels giving her a 20% passing rate.

Table 17
Student Demographics & Texas Assessment of Knowledge & Skills Results (María)

| | Economically Disadvantaged | LEP | All Student % Met Standard | LEP % Met Standard |
|-------------------|----------------------------|-------|----------------------------|--------------------|
| Campus | 92.7% | 33.6% | 74% | 63% |
| María's Classroom | 100% | 26.3% | 52.6% | 20% |

As the findings summarized above show, María scored toward the high end of the scale in her lesson plans and implementation of those lesson plans. While she did not

have a degree in mathematics or certified in secondary mathematics, María was able to produce some results with her students including ELLs. However, the student achievement of the class I observed were low in comparison to the campus all student group. Only 20% of María's LEP students met standard compared to 63% at her campus. The all student group in María's classroom met proficiency at 52.6%, 21 percentage points lower than the campus all student group. So even though her lessons seemed good, her students did not perform well. Part of the success may lie in the fact that she planned all her lessons with her colleague, Jesus, case study number 3. The next section will present the findings for Jesus and then followed by a cross case analysis of the 3 case studies.

Case Study 3

Jesús, an experienced teacher, was case study 3. Jesús had taught 7th grade mathematics for twenty years and had come into education after having worked in the private sector. Of the three case studies, only Jesús held a bachelor's in mathematics, and was certified to teach high school mathematics. While in his late fifties, Jesús demonstrated a zest for teaching mathematics and compassion for his students. Like his colleagues, Jesús remarked that he did not feel qualified to teach English language learners, in particular students who did not have previous experience in U.S. schools. Despite his concerns, Jesús' goal was for his students to increase their understanding and to make connections among mathematics, other disciplines, and their world. Jesús' compassion for all his students facilitated authentic, social interaction in which ELLs were full participants. By inviting all students to participate in the community discussion, he fostered the development of conversational and academic English (Chamot &

O'Malley, 1996).

Findings from the Jesús Case Study

The presentation of the findings is organized around the research questions and sub-questions. For each, I provide the data from the appropriate sources: lesson plans, lesson observations, interviews, and archival data.

Research Question 1

The first research question was: *what instructional practices do middle school mathematics teachers in this cross case study use in classes with ELLs and sub-question: how do the different practices result in differential student achievement between mainstream students and ELLs?* To answer these questions, I gathered data from Jesús' lesson plans, my observations, interviews with Jesús, and archival data.

Findings from Lesson Plans

As with the other case studies, Jesús followed primarily the district-selected *CSCOPE* curriculum to plan his lesson. Jesús taught 7th grade mathematics five times a day. Jesús' class was composed of 18 males and 3 females. Of the 18 students 3 were classified as ELLs, of which two were considered recent immigrants who had just entered U.S. schools for the first time.

A review of the lesson plans revealed that *CSCOPE* was based on the 5E model, and teachers were expected to take their students through all the parts of the model. The lesson plans always began with the identification of a mathematics concept or principle the students were to learn. Next, the teacher had to identify real world problems or situations where the principle arises. These problems translated into mathematics formed the core of the learning goals and process. As the lesson develops, the teacher is to

provide focused explanations to increase students' understanding of the mathematics.

Jesús commented that he planned regularly with his fellow 7th grade teachers. “We meet and plan the lessons for the week; however, we each have our own way of presenting the lesson to the students. After we implement the lesson, we often discuss how our students reacted and learned the concepts presented. We all know that it is not enough to know the concepts, we also have to know how our students think and what activities to use in order to engage them in the lesson.”

The *Lesson Plan Rubric* (Appendix B) was designed to assess the quality of lessons in relation to effective mathematics instruction and the degree the plan worked on the development of processes/facts/vocabulary. The lessons, planned in collaboration with the 7th grade mathematics team, were generally part of a unit as designated by the CSCOPE curriculum. The content objectives, activities for the day’s lesson along with a language objective were written on the lesson plans as well as on the classroom white board. Handouts that the students were expected to complete as part of the lesson were also collected. The *Lesson Plan Rubric*, used to rate the lesson plans, required rating 10 key indicators as described in Chapter 4.

Table 18 presents results of the lesson design ratings for Jesús. I rated each of the 10 key indicators using a 1 (not at all) to 5 (to a great extent) scale. The lesson plans were rated at the high end of the scale for the design of each lesson reflected careful thought.

The lessons were well-organized and drew on the students’ prior knowledge.

Table 18
Lesson Plans Ratings (Jesús)

| | | | | | | | | | | |
|------------|------------|------------|--|--------|--------|---|---|--------------|----|------|
| Lesson1=■ | Lesson 2=◆ | Lesson 3=❖ | | Not At | ←————→ | | | | To | Mean |
| Lesson 4=□ | | Lesson 5=□ | | All | | | | Great Extent | | |
| | | | | 1 | 2 | 3 | 4 | | 5 | |

| | | |
|---|----------------|-----|
| 1. The design of the lesson incorporated tasks, roles & interactions consistent with investigative mathematics. | ■ ◆ ❖ □ □ | 4.8 |
| 2. The instructional strategies and activities used in this lesson reflected attention to students' experience, preparedness, prior knowledge, and/or learning styles. | ■ ◆ ❖ □ □ | 4.8 |
| 3. The design of the lesson reflected careful planning and organization. | ◆ ■ ❖ □ □ | 4.8 |
| 4. The resources available in this lesson contributed to accomplishing the purposes of the instruction. | ■ ◆ ❖ □ □ | 4.6 |
| 5. The instructional strategies and activities reflected attention to issues of access, equity, and diversity for students (e.g., cooperative learning, language-appropriate strategies/materials). | ■ ❖ ◆ □ □ | 4.6 |
| 6. The design of the lesson encouraged a collaborative approach to learning among the students. | ■ ◆ ❖ □ □ | 5 |
| 7. Adequate time and structure were provided for "sense-making. | ❖ ■ ◆ □ □ | 4.8 |
| 8. Measurable language and content objectives were visible in the classroom. | ■ ◆ ❖ □ □ □ | 5 |
| 9. Adequate time and structure were provided for wrap-up. | ■ ◆ ❖ □ □ | 4.6 |
| 10. Explicit listing of key vocabulary was evident in the classroom. | ■ ◆ ❖ □ □ | 5 |

Indicator 1, *the design of the lesson incorporated tasks, roles & interactions consistent with investigative mathematics*, was rated at the higher end of the scale with a mean of 4.8. In a lesson on ratios and proportional relationships, Jesús planned the following multi-step proportional reasoning problem. When teaching a multi-step problem, involving percent increase or decrease, the student needs to pay attention to the whole. Example of a real world problem: The price of the iPod is \$150.00 but has a 15% discount. What is the price of the iPod after the discount? To calculate this problem, Jesús took the student through the following steps:

Step 1: $\$150.00 \times 15/100 = \22.50 (Multiple the whole \$150.00 by 15% to calculate the 15% discount)

Step 2: $\$150.00 - \$22.50 = \$127.50.00$ (Subtract the 15% discount [\$22.50] from the whole [\$150.00] to determine the final cost [\$127.50])

For the second problem Jesús used the same whole [\$150.00] but increased the cost by 15%.

Step 1: $\$150.00 \times 15/100 = \22.50 (Multiple the whole \$150.00 by 15% to calculate the 15% increase)

Step 2: $\$150.00 + \$22.50 = \$177.50.00$ (Add the 15% discount [\$22.50] to the whole [\$150.00] to determine the final cost after the increase [\$177.50])

Indicator 2, *the instructional strategies and activities used in this lesson reflected attention to students' experience, preparedness, prior knowledge, and/or learning styles*, earned a mean of 4.8. One particular lesson reflected attention to students' experience, preparedness, prior knowledge, and/or learning styles. In this lesson, he added a semantic map to preview vocabulary. In this activity he drew a circle around the vocabulary word, *estimate*, to be used and the students wrote different words such as *almost*, *guess*, that they associated with the word, *estimate*.

The average mean for indicator 3, *the design of the lesson reflected careful planning and organization*, was 4.8. Throughout the study, it became evident that Jesús thought carefully as he prepared his lessons. He selected classroom activities to enhance the students' learning, and his assessments generally grew from the nature of the tasks he was asking his students to perform. An example is the following frequency table given to the students after they completed a frequency table in class.

Fill in the missing number in the Broken crayons per box table below.

8 23 20 23 5 8 24 19 13 17 17 0 4 0 8 17 7 15

| Broken crayons per box | |
|--------------------------|-----------------|
| Number of broken crayons | Number of boxes |
| 0-4 | 3 |
| 5-9 | 5 |
| 10-14 | |

| | |
|-------|---|
| 15-19 | 5 |
| 20-24 | 4 |

Indicator 4, *the resources available in this lesson contributed to accomplishing the purposes of the instruction*, was rated at a mean of 4.6. Additional resources for his lessons were available on a table in the front of the classroom. In addition, Jesús had geometrics shapes, colored pencils, scissors, and colored paper in cubbies along the classroom wall. All resources were easily accessible for students to use when needed.

Indicator 5, *the instructional strategies and activities reflected attention to issues of access, equity, and diversity for students (e.g., cooperative learning, language-appropriate strategies/materials)*, also received a mean of 4.6. While the CSCOPE mathematic lessons were based on the NCTM mathematics standards and the TEKS, during an interview, Jesús commented that he felt there were gaps in the lessons and often supplemented from resources he had obtained from workshops he had attended over the years.

Indicator 6, *the design of the lesson encouraged a collaborative approach to learning among the students*, scored a 5 mean. While all the lessons reviewed encourage a collaborative approach one lesson in particular embodied the concepts especially well. The students were assigned to work on a symmetry lesson in collaborative grouping. What made this lesson outstanding was that students completed half of a Christmas tree drawing and then traded with a partner who finished the other half.

Indicator 7, adequate time and structure were provided for “sense-making, received a mean of 4.8. The lesson plans indicated notes, so that time was allocated for students to synthesize what they had just learned. In a lesson on frequency tables, Jesús had written “allow time for students to discuss in their own terms what they have

learned.”

Indicator 8, *measurable language and content objectives were visible in the classroom*, received a mean of 5. Each time, I observed a lesson, the content and lesson objective for the day were written on the classroom white board. Additionally, the Promethium Board was on and Jesús had a warm-up activity ready for the students.

Indicator 9, *adequate time and structure were provided for wrap-up*, received a 4.6 mean. The five lessons reviewed indicated that Jesús, allowed time for his students to answer and generally had plans for a wrap-up for each lesson. For one lesson he had prepared an exit ticket. This strategy was a slip of paper that each student had to complete and submit as they left the classroom. The basic principle of the activity was that students had to list three things they had learned during the lesson and one area they needed additional help in.

Explicit listing of key vocabulary was evident in the classroom, indicator 10, had a mean of 5 because it was evident that Jesús had his students work on vocabulary. Not only did Jesús have word walls hanging in the classroom, he also had his students work with vocabulary journals. For example, on Mondays he directly taught at least five words per week. He would use PowerPoint, and his students wrote their terms and descriptions and examples in a vocabulary journal. For every word, each student entered a description of that word and then either an example or drawing of that word. By the end of the week, students entered a new insight, something new they learned about that word throughout the week. Jesús would check for understanding of vocabulary in class by engaging in discussions with students, with particular students, and by walking around and spot-checking their vocabulary journals. At the end of the week, he assessed his students on

the vocabulary for that week, and at the end of every unit he created a unit vocabulary assessment.

Findings from Lesson Observations

Data from the lesson implementation was gathered through the *Lesson Observation Rubric* (Appendix C) that was described in Chapter 4. Best practices for teaching ELLs was embedded into the *Lesson Observation Rubric*. Jesús often supported a problem-solving approach in the mathematics classroom because it engages students in inquiry, prompting them to build on and improve their current knowledge as they construct explanations that help them solve the task at hand. Table 17 below depicts lesson observation ratings for the five lessons observed in Jesús' 7th grade mathematics classroom.

Jesús scored high on all indicators. On the lesson implementation, he modified his presentation and added information to enhance understanding or to move the students to a related more complex concept. An example is how he taught the students to deduct and then add percentage discounts on the iPod problems. Additionally, to support his students' content learning, Jesús had established a rapport with his students and a set of norms for students to turn and talk to each other as they work together. Jesús served as a facilitator in his lessons—he laid out the task, and then invited the students to dig into the problems.

Table 19
Lesson Implementation Ratings of Key Indicators (Jesús) Scale 1-5

| Lesson Implementation Ratings of Key Indicators (Leas) Scale 1-5 | | | | | | | |
|--|------------|------------|---------------------------|---|---|------|---------|
| Lesson1=■ | Lesson 2=◆ | Lesson 3=❖ | Not Effective ↔ Effective | | | Mean | |
| Lesson 4=□ | Lesson 5=□ | | 1 | 2 | 3 | 4 | 5 |
| 1. The instructional strategies were consistent with investigative mathematics | | | | | | | ■◆❖□□ 5 |

| | | | |
|--|----|-------|-----|
| 2. The teacher appeared confident in his/her ability to teach mathematics | | ■◆❖□□ | 5 |
| 3. The teacher's classroom management style/strategies enhanced the quality of the lesson | ◆ | ■❖□□ | 4.8 |
| 4. The pace of the lesson was appropriate for the developmental levels/needs of the students and the purposes of the lesson. | | ■◆❖□□ | 5 |
| 5. The teacher was able to "read" the students' level of understanding and adjusted instruction accordingly. | ■ | ❖◆□□ | 4.8 |
| 6. The teacher, where appropriate, used models or manipulatives to demonstrate concepts and/or processes | | ■◆❖□□ | 5 |
| 7. The teacher's questioning strategies were likely to enhance the development of student conceptual understanding/problem solving (e.g., emphasized higher order questions, appropriately used "wait time," identified prior conceptions and misconceptions). | ❖ | ■◆□□ | 4.8 |
| 8. The teacher think-alouds technique to narrate the problem-solving process. | ■◆ | ❖□□ | 4.6 |
| 9. The teacher used informal language to increase understanding and demonstrate the various thought processes and steps to follow in solving a problem. | ■ | ◆❖□□ | 4.8 |
| 10. The teacher used clarity checks to check for understanding of the task and processes involved before students get started working on the assignment. | | ■◆❖□□ | 5 |
| 11. The teacher presented activities that involve application problems in contextualized situations. These activities encouraged critical thinking and reasoning along with basic skills development and practice. | ■ | ◆❖□□ | 4.8 |
| 12. The teacher encouraged the use of diagrams and other visual aids to help students develop concepts and understanding. | | ■◆❖□□ | 5 |

Indicator 1, *the instructional strategies were consistent with investigative mathematics*, earned a mean of 5. Indicator 1 was evidenced throughout the observations; however, it was especially clear during a lesson on symmetry. During this lesson, Jesús introduced the concept of symmetry to his 7th grade class by first demonstrating the concept with examples. The concept development unfolded by engaging students in (a) exploring the concept, (b) investigating its application to familiar cases, (c) making

connections to meaningful contexts, and (d) expanding it in a more challenging activity. First, he used his body to illustrate the idea of symmetrical objects and line of symmetry. For instance he explained and acted: “If I fold my body, eye will fold on eye, ear will fold on ear, hands will fold on hands, fingers will fold on fingers.” Students were attentive and excited. Students worked individually on specific examples, and then participated in a teacher-led discussion about their exploration. Their task was to write the alphabet in capital letters and find which letters have a line of symmetry. The teacher drew examples on the Promethium Board A, B, C, D, E, to explain, demonstrate, and discuss possible lines of symmetry. Students then worked on their own for a few minutes, investigating the symmetrical properties of each letter, expressing some puzzlement about letters like N and Z.

Indicator 2, *the teacher appeared confident in his/her ability to teach mathematics instructional strategies were consistent with investigative mathematics*, earned a mean of 5. One of the indicators of teacher’s conceptual understanding of mathematics is an ability to encourage and value the active participation of all students in meaningful discourse in the classroom. Jesús’ lesson delivery was often energetic and always had the real-life connections that helped his students relate to the content in such a way that would allow them to internalize the skills and knowledge he was trying to impart. Additionally, during an interview Jesús related, “I choose activities based on their emphasis on real context mathematics applications and on the creation of connections in mathematics and the student’s world.” His activities were also selected based how they enhanced problem-solving skills and encouraged students’ responsibility for their own learning.

For indicator 3, *the teacher's classroom management style/strategies enhanced the quality of the lesson*, Jesús earned a mean of 4.8. Jesús also scored high on this indicator because of his classroom management style. A theme consistent throughout the observations was the climate of mutual respect between and among the students and Jesús. During one conversation, Jesús stated, "The students know my expectations. I expect them to work from bell ring to bell ring." "I also expect that students exhibit appropriate behavior in my classroom. I am there to help them learn, and I believe they know that."

Indicator 4, *the pace of the lesson was appropriate for the developmental levels/needs of the students and the purposes of the lesson*, earned a mean of 5. Jesús scored a perfect score because of the strategies implemented during the observations. Jesús was cognizant of the ELLs in his classroom and often met their academic needs with different strategies. In one lesson on fractions, he translated the problem when he realized some of his students were having difficulty with the English language.

Indicator 5, *the teacher was able to "read" the students' level of understanding and adjusted instruction accordingly*, earned a mean of 4.8. Jesús scored high on this indicator because he modified his lessons and added information to enhance understanding or to move the students to a related more complex concept. Jesús served as a facilitator in his lessons—he laid out the task, and then invited the students to dig into the problems. In a discussion on symmetry it became clear that he valued his students' input on problem solving. Throughout the observations, he led his students through a high level of critical thinking and encouraged students to take risks. Jesús explained that all several skills were interwoven in the lesson, "When I provide my students with a

problem-solving application of mathematics in a real context, I have several purposes in mind: to deepen a student's understanding of mathematics, to help the student make connections, and to help the student build confidence in himself or herself as a problem solver." Jesús reiterated María's sentiments as he stated that it was important that his students be able to perform mathematical algorithms such as solving quadratic equations or using matrices to solve linear systems.

Indicator 6, the teacher, *where appropriate, used models or manipulatives to demonstrate concepts and/or processes*, earned a mean of 5 During a lesson on ratios and proportional relationships (stretching and shrinking) Jesús began the lesson by having students enlarge a figure using a rubber band stretcher. The students first compared figures using vocabulary such as corresponding sides and angles. No numbers were used at this time; students looked at the figures geometrically and then moved into solving the problems algebraically. Additionally, Jesús used models or manipulatives to demonstrate concepts and/or processes such as cloze sentences as effective methods for improving vocabulary, syntax, and student understanding of concepts.

For indicator 7, *the teacher's questioning strategies were likely to enhance the development of student conceptual understanding/problem solving (e.g., emphasized higher order questions, appropriately used "wait time" identified prior conceptions and misconceptions)*, Jesús received mean of 4.8. The 5 lessons reviewed received high marks in this measure because Jesús often used open-ended questions as a focus for the lesson. During the introductory discussion on linear equations, slope and y-intercept, Jesús allowed students the opportunity to challenge one another's answers by asking questions such as "Is this correct?" and "Does anyone have a different idea?" After the discussion,

the students worked in pairs on plotting. When they had completed the assignment, students went to the front of the room and placed pictures on the overhead version of the grid, and Jesús allowed other pairs to comment on the correctness of the placement.

Indicator 8, *the teacher think-alouds technique to narrate the problem-solving process*, earned a mean of 4.6. In this indicator, Jesús did not score a perfect score because think-alouds were not observed for every lesson. He did implement a think-aloud during a lesson on proportional relationships to solve multi-step ratio and percent problems. For this lesson he began by reviewing the keys terms: “Percent is the same as saying Per 100. For example, if 20 liters out of every 100 liters in a mix are orange juice, then the juice mixture is 20% orange juice.” To connect to a real world problem, Jesús used the following problem:

Stores will often sell items for a discounted sales price. The store will discount an item by a percent of the original price. For example, an iPod costs \$150.00 but is discounted by 15%. To find the amount of discount calculate 15% of \$150. ($\$150.00 \times 15/100 = 22.50$). Subtract the discount from the original price to find the sale price. ($\$150.00 - \$22.50 = \$127.50$ sales price). Jesús also discussed the terms used for discounted items: 50% Off, Save 50%, Discounted by 50%.

The mean of 4.8 was totaled for indicator 9, *the teacher used informal language to increase understanding and demonstrate the various thought processes and steps to follow in solving a problem*. In a lesson on fractions, Jesús noticed that some of students did not understand the lesson. To facilitate learning of his Spanish-speaking students, Jesús repeated the example in Spanish.

Encontramos que si todos los estudiantes comparten la pizza, todos recibirían $1/7$

de la pizza. Pero eso era cuando cortamos la pizza en siete piezas y a cada estudiante le tocó una. ¿Qué si cortáramos la pizza de modo que a cada estudiante le tocara dos piezas? ¿Qué fracción de la pizza entera entonces recibiría cada estudiante? (If seven students share a pizza, they will each receive $\frac{1}{7}$ of the pizza. That is if the pizza is divided in seven slices. However, what if each student receives two slices? What fraction of the pizza will each student receive?) Once the students understood the concept, Jesús continued with the lesson on fractions.

Indicator 10, *the teacher used clarity checks to check for understanding of the task and processes involved before students get started working on the assignment*, earned a mean of 5. Jesús was rated a perfect score on this indicator because he was always cognizant of his students' understandings during a lesson. An example was a pre-taught method he had taught his students. As his students worked through a lesson on frequency tables, a few students raised their hands and wiggled their fingers. As soon as Jesús noticed he walked to each of the students and assisted them with the assignment. When asked about the finger wiggling, Jesús mentioned that he had previously taught the students to wiggle their fingers if they needed clarification or help with the problem solving processes.

Indicator 11, *the teacher presented activities that involve application problems in contextualized situations; these activities encouraged critical thinking and reasoning along with basic skills development and practice* earned a mean of 4.8. During the introductory discussion on linear equations, slope and y-intercept, Jesús allowed students the opportunity to challenge one another's answers by asking questions such as "Is this correct?" and "Does anyone have a different idea?" After the discussion, the students

worked in pairs on plotting. When they had completed the assignment, students went to the front of the room and placed pictures on the overhead version of the grid, and Jesús other pairs were allowed to comment on the correctness of the placement.

The mean of 5 was averaged for indicator 12 *the teacher encouraged the use of diagrams and other visual aids to help students develop concepts and understanding*. During a discussion about symmetry in a real world setting, Jesús presented examples that helped students make connections between symmetry and familiar contexts. Then he continued soliciting students' input of their own examples. He welcomed their ideas and expanded the discussion around each example. In the last 15 minutes of the lesson, students worked on a hands-on activity designed to apply the concept of symmetry. Students were instructed to draw the left side of a Christmas tree (on graph paper), add decorations of their choice, (e.g., half of a star), then exchange with their neighbor and draw the other half of their neighbor's tree.

Jesús' attention to the objectives, alignment of activities and resources and his awareness of his students' needs warranted high scores on the lesson implementation. While the lessons implemented were difficult at times, they were engaging and captured the students' attention. One reason may have been Jesús' involvement in school-based curriculum development that was coherent within the context of his classroom. While Jesús commented that he collaborated with teammates in the alignment of curriculum materials with CSCOPE lessons, he commented that he analyzed whether the materials worked with his students. This situation may have produced ownership on the part of Jesús and led to better implementation and impact.

In terms of student achievement, only curriculum development for mathematics

teachers was found to relate to student achievement. Mathematics teachers with students who have lower achievement were found to engage in more long-term curriculum development. One explanation is that these mathematics teachers may have engaged in more curriculum development because they had students who were low achieving and unresponsive to the traditional curriculum, and they strove to find and create something better. This is good news in that it appears the statewide system of professional development is reaching the teachers in most need. As was the case with the two other teachers in this study, most of Jesús' students had not met proficiency standards on the six-grade mathematics TAKS the prior year. Table 22 below presents a comparison of student demographics and the proficiency percentages for the class I observed in comparison to the entire grade level achievement on the 7th grade mathematics TAKS.

Findings from Classroom Culture

When I first walked into Jesús' classroom I was amazed at the display of student work. A word wall decorated the inside of the door and displayed the academic language to be learned that particular week. On the wall were huge posters resembling graph paper with number lines, word problems and other problem-solving activities. Hanging from the ceiling were numerous shapes made from foam and other material. At the front of the room, a table displayed more student projects. Some of the work resembled robots that had been constructed of all sizes, colors and materials. The desks were in cooperative grouping with three students to each group.

Table 20 presents the ratings for Jesús' classroom culture. The culture in the classroom was rated using the second part of the *Classroom Culture Rubric* (Appendix D) described in Chapter 4.

Table 20
Classroom Culture Ratings of Key Indicators (Jesús) Scale 1-5

| | Lesson 1=■ | Lesson 2=◆ | Lesson 3=❖ | Lesson 4=□ | Lesson 5=□ | Not Effective ←————→ Effective | | | | | Mean |
|--|------------|------------|------------|------------|------------|--------------------------------|---|---|---|-------|------|
| | | | | | | 1 | 2 | 3 | 4 | 5 | |
| 1. Active participation of all was encouraged and valued | | | | | | | | | ■ | ◆❖□ | 4.8 |
| 2. There was a climate of respect for students' ideas, questions, and contributions. | | | | | | | | | | ■◆❖□□ | 5 |
| 3. Interactions reflected collegial working relationships among students (e.g. students worked together, talked with each other about the lesson). | | | | | | | | | | ■◆❖□□ | 5 |
| 4. Interactions reflected collaborative working relationships between teacher and ELLs. | | | | | | | | | | ■◆❖□□ | 5 |
| 5. The climate of the lesson encouraged ELLs to generate ideas, questions, conjectures, and /or propositions. | | | | | | | | | ■ | ◆❖□□ | 4.8 |
| 6. Intellectual rigor, constructive criticism, and the challenging of ideas were evident. | | | | | | | | | ■ | ◆❖□□ | 4.8 |
| 7. The experiences and cultures of ELLs are valued. | | | | | | | | | | ■◆❖□□ | 5 |
| 8. ELLs are allowed to record answers or solution steps in their own native language. | | | | | | | | | | ■◆❖□□ | 5 |
| 9. Focus is placed on the meanings ELLs are conveying instead of on grammar and usage. | | | | | | | | | | ■◆❖□□ | 5 |

Indicator 1, *active participation of all was encouraged and valued*, was given a 4.8 mean. In one particular instance, a student was having difficulty remembering how to solve a problem on ratios and other students wanted to answer; however, Jesús pointed out, “Let’s wait until Samantha recalls it to her mind.” With this method, Jesús facilitated that all students participate in the collective activity and signaled that all thoughts were worthy of expression.

Indicator 2, *there was a climate of respect for students’ ideas, questions, and contributions*, resulted in a mean of 5. During an interview, Jesús commented on his

concern for his English language learners,

Some come to us with some mathematics background, and some come with skills that are considerably below level, but the biggest problem is the language barrier.

It is very difficult to teach mathematics to students that do not understand the English language. While I am fully proficient in Spanish, I have been instructed that this campus is a dual language campus and mathematics must be taught in English only. What is even more frustrating is that I was not included in the trainings for dual language nor did I receive any resources.

Despite the language obstacles his students faced, Jesús believed that all students could learn mathematics, even when they were experiencing difficulties. To help his students meet his high expectations, he expected his students to take responsibility for their own learning, and he provide the increased support necessary to help students meet these higher standards.

Indicator 3 *interactions reflected collegial working relationships among students (e.g. students worked together, talked with each other about the lesson)*, receive a mean of 5. During the introductory discussion on linear equations, slope and y-intercept I noted that, Jesús seemed to know his students well and was easily able to get all students participating by calling on both volunteers and non-volunteers. Both the teacher and students were respectful of each other's thoughts. Discussions were lively and included multiple students' perspectives. Jesús had an ability to naturally adjust instruction based on students' level of understanding and the degree of "sense-making" within the lesson.

Indicator 4, *interactions reflected collaborative working relationships between teacher and ELLs*, received a mean of 5. In this classroom, students have mathematical

conversations and are able to state their thoughts, and are also comfortable with making uncertainty explicit. For example, Jesús' students knew it was okay to say what they thought, and it was also okay to disagree and change their minds. Jesús' classroom demonstrated a way to honor the process of developing mathematical understanding in students. The students' independence in their math work rested on a climate of acceptance and mathematical risk-taking. Additionally, to support his students' content learning, Jesús had established a rapport and a set of norms for students to turn and talk to each other as they work together.

In line with the other indicators, indicator 5, *the climate of the lesson encouraged ELLs to generate ideas, questions, conjectures, and /or propositions*, earned a 4.8 mean. During a lesson on linear equations, I documented that the classroom culture in this 7th grade mathematics class was “phenomenal.” I recorded an extraordinary amount of excitement, and the fact that the content was rigorous. Jesús often facilitated a safe learning environment for all students to participate. His promotion of collective responsibility in the classroom community was evident by utterances such as, “could someone help Elsa, what is Elsa trying to say?” He also encouraged silent students to participate by asking their opinions, “Antonio do you agree?” Jesús' value of his students was often expressed with statements such as “very good question; or does anyone have any other ideas?” In other instances, it was clear that Jesús set the tempo of interaction in the room.

Indicator 6, *intellectual rigor, constructive criticism, and the challenging of ideas were evident*, had a mean of 4.8. Throughout the observations, it became clear that Jesús added intellectual rigor and challenged his students. In a lesson on frequency tables, Jesús

presented the following problem on the Promethium Board and asked his students to work in dyads to solve the problem.

Victor tabulated the number of peaches sold by vendors in 3 hours on a Sunday. Find the difference between the number of vendors who sold at least 16 peaches in 3 hours on Sunday and the number of vendors who sold at most 15 peaches in the same time.

| NUMBER OF PEACHES | FREQUENCY (No Of Vendors) |
|-------------------|---------------------------|
| 1 – 5 | 1 |
| 6 – 10 | 2 |
| 11 – 15 | 10 |
| 16 – 20 | 16 |
| 21 – 25 | 1 |

As Jesús drew a table on the Promethium Board, the students developed a table of their own and began filling it in. To help his students, Jesús asked volunteers to explain each step of the problem. Before asking the first volunteer, Jesús gave the students a few minutes to begin work on their own frequency table. The first student presented the following: *first find the number of vendors that sold at least 16 peaches = the number of vendors who sold 16-20 peaches + number of vendors who sold 21-25 peaches = 16 + 1 = 17*. Before allowing another student to present the next step, Jesús asked the class if the information was correct. The next student presented step two: *find the number of vendors who sold less than 15 peaches = number of vendors who sold 1-5 peaches + vendors who sold 6-10 peaches + vendors who sold 11-15 peaches = 10 + 2 + 1 = 13*. Again, Jesús conducted a clarity check before continuing. A third student presented the final step: *find the difference between vendors who sold at least 16 and those who sold at most 15 = 17 - 13 = 4*.

Indicator 7, *the experiences and cultures of ELLs are valued*, earned a mean of 5.

Jesús scored a perfect score because he was cognizant that in addition to having to build their oral English skills, his students also needed to acquire reading and writing skills in English, while at the same time learn mathematics. To Jesús it was important that his students learn the English language but not at the expense of their native language, so he often translated words, phrases, and entire problems. He also seemed to have a strong understanding that representing information in non-linguistic ways is also an important consideration. Jesús commented, “Sometimes, I make changes to help my students understand mathematics concepts. For example, the idea of slope can be expressed using graphs of lines, algebraic symbols and formulas, tables of values, or with contextual information (e.g., the fixed cost of an item is the slope of a cost function for that specific item).”

Indicator 8, *ELLs are allowed to record answers or solution steps in their own native language*, scored a mean of 5. On several occasions, I documented that Jesús spoke to his students in Spanish and allowed them to converse in Spanish while problem solving. When asked why he allowed his students to have discussions in Spanish, Jesús commented that students needed to use their first language to learn the concept and then learn the English academic language. Jesús allowed his ELLs to learn both the language and content together.

Indicator 9, *focus is placed on the meanings ELLs are conveying instead of on grammar and usage*, also garnered a mean of 5. During several observations, Jesús asked his students to write about specific problems. For example, in one lesson, the students were instructed to explain a frequency table on classroom grades where 4 students had scored below 75, 14 scored between 76-80, 2 scored between 81-85, 8 scored between

86-90, 5 scored between 91-95 and 1 scored between 96-100. This assignment had at least five steps so the teachers allowed students to begin in class and finish at home. When asked how he graded the assignment, Jesús replied, “I grade on content and do not take points for grammar and usage. If the students write enough to indicate that they understood the concept, I generally give them full credit for the assignment.”

Jesús received high marks because the lessons evidenced strategies to assist ELLs with learning language while learning mathematics contents as well. The lessons were well organized and activities aligned with the objectives. On several occasions Jesús used informal language to increase understanding and demonstrate the various thought processes and steps to follow in solving a problem. Additionally, he implemented clarity checks to check for understanding of the task and processes involved before students began working on the assignment.

Research Question 2

Data for the first part of research question 2 *what effect does the academic background and professional development of mathematics teachers in this cross case study have on the academic achievement of second language learners*, was obtained through a section of the participant questionnaire and archival records such as college transcripts.

Findings in Teacher Mathematics Academic Background

Based on his college transcripts, Jesús had a major in mathematics with a minor in biology. Of the 36 hours of mathematics, 30 hours were in advanced mathematics courses. Additionally, Jesús had completed the required 18 hours in pedagogy and had participated in student teaching at a high school. Once, he finished his course work, Jesús

applied for and took the mathematics exam for certification in teaching secondary mathematics. Prior to an observation, Jesús commented on his credentials, “Some of the classes I took in college were quite demanding, but they prepared me for the mathematics certification exam.” When I took the certification exam, I was one of 15 that passed it the first time.” The Texas Examination for Texas Educators (TExES) for mathematics contains a strand for "Knowledge Teachers Should Know" and a strand for "Things Teachers Should Do." Potential teachers must demonstrate that they not only know the content but that they have the skills to impart the content to students.

In addition to postsecondary education, everyday teaching experience provides an opportunity for teachers to gain knowledge and skills about subject matter and teaching that subject matter. Jesús had extensive teaching experience for he had taught mathematics at the same middle school for twenty years. During those years, he had developed a set of beliefs for teaching mathematics. Jesús believed that students learn best by doing and reasoning about mathematics on their own was consistent with his dynamic view of mathematics.

Research Question 2

To answer the second part of research question 2 *what effect does the academic background and professional development of mathematics teachers in this cross case study have on the academic achievement of second language learners*, I gathered the data needed through a questionnaire and through the district’s professional development archives.

Findings in Professional Development

Table 21 demonstrates the professional development sessions attended by Jesús. The sessions listed are very similar to those of his colleagues for the three were often sent to the same trainings. Of the twelve sessions listed four were content-focused professional development. The other sessions were teaching methodologies or pedagogy. An emerging body of work suggests that professional development that focuses on both subject-matter content and how students learn that content may be an especially important element in changing teaching practice (Desimone, Smith, and Ueno 2006).

Table 21
Professional Development Types (Jesús)

| Professional Development Session | Mathematics Content | Other | Strategies for English Language Learners |
|---|---------------------|-------|--|
| Connected Math | ✓ | | |
| Ignite Learning Program: Math for MS Teachers | ✓ | ✓ | |
| Testing Strategies | | | |
| Instructional Strategies | | ✓ | |
| Region I Collaborative CSCOPE | ✓ | | |
| Cooperative Learning Strategies | | ✓ | ✓ |
| ELPS Math Academy | | | ✓ |
| Texas Math Academy | ✓ | | |
| ESL Institute for Secondary Teachers-Experienced | | | ✓ |
| Co-Teaching and Strategies to Meet the Needs of Diverse Exceptional Learner | | | ✓ |
| CHAMPS: Conversation, Help Activity, Movement, | | ✓ | |

Participation

✓

✓

Write to Learn

The sessions under the content and other columns attended by Jesus seemed to be quality workshops that often provided new strategies or strengthen those Jesus used in his classroom. For these professional development sessions, Jesus shared positive remarks. However, while he attended five workshops under the Strategies for English Language Learners column, he shared a concern for not knowing enough to help his ELLs learn language and mathematics content.

Findings from Student Achievement

To connect student achievement to Jesús' instruction and to answer research question 3: *what effect does the academic background of mathematics teachers in this cross case study have on the academic achievement of second language learners?* The results from the 2011 Texas Assessment of Knowledge and Skills (TAKS) 7th grade student were used.

As was the case with the two other teachers in this study, most of Jesús' students had not met proficiency standards on the six-grade mathematics TAKS the prior year. Table 22 below presents a comparison of student demographics and the proficiency percentages for the class I observed in comparison to the entire grade level achievement on the 7th grade mathematics TAKS.

Table 22
Student Demographics & Texas Assessment of Knowledge & Skills Results (Jesús)

| | % Economically Disadvantaged | % LEP | All Student % Met Standard | LEP % Met Standard |
|------------------|------------------------------------|----------|----------------------------------|--------------------|
| Campus | 92.7% | 33.6% | 74% | 63% |
| Jesús' Classroom | 81.8% | 16% | 100% | 100% |

As noted in table 22 above, the majority of students in the classroom observed are from economically disadvantaged families. With three LEP students in his classroom, the percentage of LEP students enrolled was considerably lower than the average for the entire campus. However, the scores for ELL and non-ELLs are notable, since both groups met proficiency standards. Jesús' class met the standard on the mathematics TAKS with 100%, 26 percentage points above that of the all student group. Jesús' LEP students met proficiency standards 43 percentage points higher than the campus 7th grade average.

Throughout the study, Jesús' knowledge and background in secondary mathematics became evident. Of the three case studies, he scored the highest marks in lesson design and lesson implementation. Additionally, his students had higher proficiency rates on the TAKS.

The fact that Jesús had earned a degree in mathematics and a certification in secondary mathematics was evident in his performance in the classroom and in his students' achievement. While Jesús planned his lessons and activities with his colleagues, his lesson presentations and his relationship with his students were outstanding.

A cross case analysis will be discussed in the next section. This section will compare the lesson design and lesson implementation of the three teachers in this study. The analysis will be presented in the same format as the individual case studies.

Cross Case Analysis

This cross case analysis examined the effects of mathematics teachers' academic background on the academic achievement of second language learners through case studies of three middle school mathematics teachers in a school district in close proximity to the southern Texas/Mexico border. The cross-case analysis methodology provides a

vehicle for understanding how relationships may exist among discrete cases, accumulate knowledge from the original cases, refine and develop concepts and build or test theory (Ragin, 1997). Furthermore, cross-case analysis allows the researcher to compare cases from one or more settings (Eckstein, 2002). This provides opportunities to learn from different cases and gather critical evidence to modify policy.

The three teachers profiled in this study, showed a deep understanding of their students and their needs. Their teaching practices seemed to support a classroom environment where all students could actively participate and where linguistic and cultural resources were highly valued by the teachers. A number of practices displayed in the classrooms of these teachers challenged the prevailing views in mathematics education and drew attention to the importance of the cultural and linguistic aspects of learning.

Each participant included group problem-solving activities as part of the classroom routine. Student solutions to the problems posed by their teachers were presented in a variety of ways, including written submissions with full justification for their answers and presentations of the solutions to the class, often using visuals or demonstrations. All three participants shared the belief that mathematics should be applied in realistic contexts to deepen students' understanding of mathematics and so that students recognize the value of mathematics. The three believed in the importance of students seeing the applications of mathematics within the classroom to be better prepared for applying mathematics outside of the classroom.

Developing students' confidence in doing mathematics was also important. Students require confidence to take necessary risks in problem solving, such as trying a

different approach, brainstorming, or using trial and error. The three participants developed a safe and comfortable environment that facilitated students taking risks in participating in the community discussions without fear of reprisals from the teacher or humiliation from their peers. In some instances this was accomplished when the teachers engaged students in open-ended problem solving, where there is not necessarily only one correct answer and were open to alternative solutions. This practice empowered students to develop confidence as problem solvers. As Schoenfeld (1992) reports, students' beliefs and attitudes about learning mathematics affect their understanding. The development of metacognitive skills supports the development of problem solving skills.

In the following sections, the three case students will be compared and contrasted by data sources: lesson plans, observations, interviews, and archival data.

Findings in Lesson Plans

The lessons obtained from the teachers were part of the district-adopted *CSCOPE*, a curriculum developed by a team of Regional Educational Service Centers. The lessons were complete with formal objectives, activities, manipulatives, and scripts for teachers to use if needed. While the *CSCOPE* lessons did contain some strategies for assisting English language learners, they did not contain language objectives or the Common Instructional Frameworks (CIF) strategies the teachers were required to use. The rationale behind the composition of the lessons was that any teacher, particularly new teachers, could use the lessons and teach mathematics appropriately. However, when reading the lesson plans, and then observing them in action, it was clear that the participants took the lesson plan and added or deleted as they felt the need to reach their students.

The three participants often worked in partnership when writing the lesson plans,

for the lessons were shared by the three. The three teachers planned the lessons collaboratively and often supplemented from resources they had obtained from the campus or workshops attended over their tenure. In planning the lessons, the objectives were defined as in the CSCOPE curriculum; however, they added a language objective and a CIF strategy.

In addition to designing the lesson plan, homework is also critical to reinforcing the lesson taught. It reflects the recognition that all components of instruction must be aligned in order to create coherence from specific cognitive objectives to anticipated learning outcomes. The strategy emphasizes that planning homework involves working through the assignments to ensure they incorporate the skills specified by the stated objectives. Working out problems provide teachers with insight into the nature and the details of the problems that the students are expected to do independently, and ensure that selected classroom activities are consistent with the objectives, focused toward outcomes, and linked to both.

When planning the lessons, the teachers in this study worked through homework problems. This practice allowed the teachers to scrutinize and determine the features and subtleties of the problems to foresee students' possible difficulty. Panasuk and Todd (2002) found that planning lessons is improved when teachers regularly and carefully analyzed all homework problems before assigning them. Having the homework problems worked out in a manner similar to what the students are expected to, the teachers are better prepared to proactively comment in class on troublesome homework problems as they are assigned, providing students with support necessary to complete homework independently.

The lessons developed by the participants frequently contained an extension to be used for homework or enrichment. The participants for the most part treated the extension as part of a homework assignment that was continued during the following class period. Assigning homework aligns with Cates and Skinner 's (2000) assertion that students are more likely to complete the homework assignments that have been tailored to their interests. Additonally, Namboordiri, Corwin, and Dorsten (1993) found that student achievement improved when teachers integrated homework into the summary portion of the lesson. Panasuk (2002) asserted that the alignment of objectives and homework provides a foundation for the selection of classroom activities that are consistent with both the objectives and homework. When teachers build alignment of the objectives, learning outcomes, homework, and classroom activities in their planning process, it is likely that instruction based on such planning would facilitate students' perception of the coherence of the information and would optimize learning (Panasuk, Stone, & Todd, 2002), Class activities will have more impact because the homework directly connects to the activities. Students perceive that the class activities prepare them to complete the homework assignment and that the entire lesson is coherent and integrated.

Table 23
Lesson Plans Mean

| | | | |
|---|-----|-----|-----|
| 1. The design of the lesson incorporated tasks, roles & interactions consistent with investigative mathematics. | 3.6 | 4 | 4.8 |
| 2. The instructional strategies and activities used in this lesson reflected attention to students' experience, preparedness, prior knowledge, and/or learning styles. | 3.2 | 4.2 | 4.8 |
| 3. The design of the lesson reflected careful planning and organization. | 3.2 | 4.2 | 4.8 |
| 4. The resources available in this lesson contributed to accomplishing the purposes of the instruction. | 3.6 | 3.8 | 4.6 |
| 5. The instructional strategies and activities reflected attention to issues of access, equity, and diversity for students (e.g., cooperative learning, language-appropriate strategies/materials). | 2.8 | 3.8 | 4.6 |

| | | | |
|---|-----|-----|-----|
| 6. The design of the lesson encouraged a collaborative approach to learning among the students. | 4.2 | 4 | 5 |
| 7. Adequate time and structure were provided for “sense-making. | 2.8 | 4 | 4.8 |
| 8. Measurable language and content objectives were visible in the classroom. | 5 | 5 | 5 |
| 9. Adequate time and structure were provided for wrap-up. | 3 | 4.2 | 4.6 |
| 10. Explicit listing of key vocabulary was evident in the classroom. | 5 | 4 | 5 |

While the 3 teachers used the same source for the lesson plans and planned together, they each made additions and deletions that resulted in more or less effective lesson plans. To rate each of the 5 lessons I observed, I used the *Lesson Plan Rubric* (Appendix B). The rubric was designed to appraise each lesson based on 10 indicators. As noted in Table 23, the ratings for each of the indicators varied from teacher to teacher. The highest scores were those of Jesus while the lowest were Jorge’s scores. All 3 teachers had word walls hanging in their rooms and often hung students’ work on vocabulary building activities.

For indicator 1, *the design of the lesson incorporated tasks, roles & interactions consistent with investigative mathematics*, the scores ranged from 3.6 to 4.8. Jorge’s lessons were rated a 3.6 mean because at times the lessons were not consistent with investigative mathematics. For example, in one lesson on proportions, he instructed his students to work on a TAKS review activity. Both María and Jesús were rated at the higher end of the scale. They shared a belief that mathematics should be set in a realistic content and that developing thinking and problem-solving skills is critical. In a lesson, María orchestrated several methods for solving a problem on the cost of balloons and Jesús planned multi-step proportional reasoning problems.

Indicator 2, *the instructional strategies and activities used in this lesson reflected attention to students’ experience, preparedness, prior knowledge, and/or learning styles,*

earned a mean of 3.2, 4.2, and 4.8 respectively. For one lesson, Jorge failed to address the ELLs in the classroom. María earned a higher score because she had actually written: *assess students' prior knowledge by asking questions and listing the responses on an overhead transparency on the margins of her lesson plans*. Jesús scored the highest with a semantic map to preview vocabulary. In this activity he drew a circle around the vocabulary word, *Composite Number* to be used and the students wrote examples, 4, 6, 8, 9, 12, 14 and non-examples. 0, 1, 2, 3, 5, 7, 11.

Indicator 3, *the design of the lesson reflected careful planning and organization*, had means of 3.2, 4.2, and 4.8. In some instances Jorge deviated from the CSCOPE curriculum and included activities that did not align with the objective of the lesson. An example of such a deviation is when he selected a TAKS review activity for an objective on measurement.

Throughout the study, it became evident that Jesús and María were cognizant that careful planning of activities is a significant contributor to achieving student learning. They both selected classroom activities to enhance the students' learning, and their assessments generally grew from the nature of the tasks they asked his students to perform. For example, in a lesson on proportions they had the following in their lesson plans:

*Consider the problem: if 2 gallons (of something) costs this much, how much would 5 gallons cost? What is the general idea to solve this problem? Or, if car travels this much in 3 hours, how long could it travel in 4 hours? 6 hours? 7 hours? In proportion problems you have **two things** that both change at the same rate. For example, you have dollars and gallons as your two things. You know the*

dollars & gallons in one situation (e.g. 2 gallons costs \$5.40), and you know either the dollars or the gallons of another situation, and are asked the missing one. For example, you are asked how much would 5 gallons cost. You know it is "5 gallons" and are asked the amount of dollars.

For indicator 4, *the resources available in this lesson contributed to accomplishing the purposes of the instruction*, the lessons were rated a higher mean average of 3.6, 3.8, 4.6. In this indicator, Jorge and María's scores were comparable while Jesús scored higher. For the most part, Jorge had two activities ready for immediate use while María at times did not have enough handouts for all her students. However, the resources for the other lessons were available on a table in the corner of the room. On the other hand, Jesús generally planned several activities and additional resources for his lessons were available on a table in the front of the classroom.

None of the teachers received a perfect score for indicator 5, *the instructional strategies and activities reflected attention to issues of access, equity, and diversity for students (e.g., cooperative learning, language-appropriate strategies/materials: 2.8, 3.8, and 4.6*. However, the mean for Jorge was considerably lower than the other two teachers. Jorge received low marks because there was moderate to little attention to the learning of diverse students. While the CSCOE lessons did not always contain strategies or activities outlining how to reach special populations such as ELLs, María and Jesús supplemented activities and strategies such as cooperative grouping. In reviewing the lessons developed by Jorge, I found that he did not add strategies that encouraged the learning of diverse students.

Not all the lessons actually addressed specific strategies for language learning in

the classroom. Indicator 6, *the design of the lesson encouraged a collaborative approach to learning among the students*, was one of the highest rated indicator with means of 4.2, 4, and 5. Jorge's lessons scored high because they addressed collaboration among the students either by asking them to work in dyads or in groups for most of the lesson activities. María also scored fairly high because she encouraged collaboration and often implemented manipulatives that students moved and manipulated to support their thinking and learning such as having students act out the vocabulary word they were holding until other students provided the correct definition. The lessons reviewed for Jesús' classroom encouraged a collaborative approach. In particular, a lesson on symmetry in a collaborative setting embodied the concepts especially well. What made this lesson outstanding was that students completed half of a Christmas tree drawing and then traded with a partner who completed the other half.

Indicator 7, *adequate time and structure were provided for "sense-making*, also showed a difference between Jorge (2.8) and his colleagues (4 and 4.8) because the lessons lacked an estimated timing for each of the activities planned. While the other two teachers did not receive perfect scores, most of the lessons indicated time limits for the lecture (if there was one) and the activities. The instructional strategies and activities used in this lesson reflected attention to students' experience, preparedness, prior knowledge, and/or learning styles. The design of the lesson reflected careful planning and organization.

The strongest measurement was indicator 8, *measurable language and content objectives were visible in the classroom*, which was rated with a mean of 5 for all three participants because all lessons contained a content and language objective. Each lesson

always contained both language and content objectives. While the language and content objectives were written on the lesson plans, they were also written on the classroom whiteboard.

The ninth measure, *adequate time and structure were provided for wrap-up*, received a mean average of 3, 4.2, and 4.6. This measure was also aligned to timing, an area that was not always addressed in the lessons by Jorge. In contrast, María wrapped-up lessons with a five-minute review of what the students had learned or with students themselves presenting what they had learned. The five lessons reviewed for Jesús indicated that time was allotted for students to answer and generally had plans for a wrap-up for each lesson. For each lesson, he had prepared an exit ticket. The basic principle of the activity was that students had to list three things they had learned during the lesson and one area they needed additional help in.

The last indicator in the lesson plans, *explicit listing of key vocabulary was evident in the classroom*, was rated 5, 4, and 5 respectively. A review of the lesson plans indicated that all lesson plans included the vocabulary of instruction. Additionally, the three teachers had word walls in the classroom that were changed weekly. Jorge had students work on a vocabulary journal. Often, he would refer the students to the journal for reference of mathematical terminology. Similarly, María often included the English academic language along with the Spanish version of the word in her lesson plans. For example, for a lesson on fractions she had written the term *fracción* and thereby was prepared to provide clarification of a term should students need assistance with vocabulary. Jesús had his students write their terms, descriptions and examples in vocabulary journals and something new they learned about that word throughout the

week. To check for understanding, Jesús would engage students in discussions with students, spot-check their vocabulary journals, and through a unit vocabulary assessment.

Lessons judged to be low in quality are unlikely to enhance students' understanding of important mathematics content or provide them with abilities to engage successfully in the process of mathematics. While low quality lessons fall in numerous areas, their overarching downfall tends to be the students' lack of engagement with important mathematics. Examples of low quality lessons included a lesson that had the students working on worksheets for the entire lesson. Another example was a lesson that did not follow the preceding lesson on frequency tables and did not have closure for the students.

Examples of high quality lessons include lessons that included multiple pathways to understanding a concept. Some lessons go further than simply providing content at a level that is appropriate for the students. These lessons use multiple representations of concepts to facilitate learning, both to give greater access to students with varying experiences and prior knowledge, and to help reinforce emerging understanding. Lessons judged to be effective include a variety of experiences where students would be likely to “tap into” one or more of the pathways in developing or reinforcing a concept. One example is a lesson implemented by María. In a fractions lesson plan, she included clearly defined objectives, a practice for skill attainment, and multiple forms of assessment. The lesson plan was written so that it related to previous learning. In addition, she had included expectations that students were expected to reason, to solve problems, to immediately recall basic facts, and to use algorithms for addition, subtraction, multiplication, and division. For the last quarter of the class, María, planned

to distribute a worksheet for student to complete as a review what they had learned during the lesson.

Findings in Lesson Implementation

The quality of the mathematics content of the lessons was rated based on its inherent importance in 7th grade mathematics and its appropriateness for the particular students in the class, particularly ELLs. Planning classroom activities that are developmental (advancing the development and learning) involves selection of materials and format to create an environment that promotes meaningful learning and all levels of thinking. The three participants selected content based on characteristics of the students, particularly those of their English language learners. Most often in these situations, the teachers picked content geared to address the ability levels of their students. Such a sequence of planning steps offers a basis for strong bonds and consistency between the objectives, the means for meeting the objectives, and the homework as a form of assessment. Jesus and María selected content that was at a level the students could understand and scaffolded more difficult concepts once the students had mastered the basics. However, they were cognizant that the lessons had to be challenging and had to motivate students to learn.

Table 24
Lesson Implementation Ratings of Key Indicators Mean

| | Jorge Mean | María Mean | Jesús Mean |
|--|---------------|---------------|---------------|
| 1. The instructional strategies were consistent with investigative mathematics | 3.4 | 4.4 | 5 |
| 2. The teacher appeared confident in his/her ability to teach mathematics | 5 | 5 | 5 |
| 3. The teacher's classroom management style/strategies enhanced the quality of the lesson | 3 | 4.6 | 4.8 |
| 4. The pace of the lesson was appropriate for the developmental levels/needs of the students and the purposes of the lesson. | 3.2 | 4.4 | 5 |
| 5. The teacher was able to "read" the students' level of understanding and adjusted instruction accordingly. | 3.2 | 4.2 | 4.8 |

| | | | |
|--|-----|-----|-----|
| 6. The teacher, where appropriate, used models or manipulatives to demonstrate concepts and/or processes | 3.8 | 4.2 | 5 |
| 7. The teacher's questioning strategies were likely to enhance the development of student conceptual understanding/problem solving (e.g., emphasized higher order questions, appropriately used "wait time," identified prior conceptions and misconceptions). | 2.6 | 4.2 | 4.8 |
| 8. The teacher think-alouds technique to narrate the problem-solving process. | 1.4 | 5 | 4.6 |
| 9. The teacher used informal language to increase understanding and demonstrate the various thought processes and steps to follow in solving a problem. | 3.6 | 4.2 | 4.8 |
| 10. The teacher used clarity checks to check for understanding of the task and processes involved before students get started working on the assignment. | 2.8 | 4.2 | 5 |
| 11. The teacher presented activities that involve application problems in contextualized situations. These activities encouraged critical thinking and reasoning along with basic skills development and practice. | 3.6 | 4.2 | 4.8 |
| 12. The teacher encouraged the use of diagrams and other visual aids to help students develop concepts and understanding. | 3.6 | 4.2 | 5 |

Table 24 above presents the mean of key indicators rating the lesson implementation of the three teachers. For indicator 1, *the instructional strategies were consistent with investigative mathematics*, the teachers earned a mean of 3.4, 4.4, and 5 respectively. The strategies Jorge implemented were problem-solving tasks centered on a theme or event and was often embedded in a focus question. For a probability lesson, Jorge developed an essential/guiding question: *Does probability tell you exactly what will happen in certain situations?* as a focal point. During an observation of a lesson on fractions María walked her students through the following problem:

$$\begin{aligned} \text{Complexity} &= 5, \text{ Mode} = \text{fraction} \\ \text{Solve for } n \\ 24/40 &= n/50 \end{aligned}$$

During an observation, Jesús orchestrated an exciting lesson on the concept of symmetry by introducing the concept with concrete examples. He explained that if he folded his body in half, his features would fold on each other, an eye on an eye, etc. Together the students and teacher drew examples on the Promethium Board A, B, C, D, E, to demonstrate, and discuss possible lines of symmetry. Students were attentive and excited

to begin their task to detect which letters of the alphabet had a line of symmetry. They then worked on their own for a few minutes, investigating the symmetrical properties of each letter, expressing some puzzlement about letters like N and Z.

Indicator 2, *the teacher appeared confident in his/her ability to teach mathematics*, received the highest mean average of 5. In observing Jorge, he appeared confident in his ability to teach mathematics, and he generally began his lessons with a warm-up problem. The problem was flashed on the Promethium Board, so that students could take turns working the problem as other students participated with comments. María's lessons generally opened with a brief discussion of the terms that were to be used in the lesson or connect to the previous night's homework. María often modeled procedures, had students draw pictures or used sentence stems to help ELLs during class discussions. Jesús' lesson delivery was often energetic and connected to real-life situations to help students internalize the skills and knowledge he was trying to impart. During an interview Jesús related, "I choose activities based on their emphasis on real context mathematics applications and on the creation of connections in mathematics and the student's world."

For indicator 3, *the teacher's classroom management style/strategies enhanced the quality of the lesson*, the teachers averaged 3, 4.6, and 4.8. In a lesson on proportional reasoning to solve problems, Jorge began the lesson with a warm-up and instructed students that their grade would be based on the amount of work each produced and the test taking strategies they used, such as underlining, approximation, estimating, eliminating and justifying answer choices. Similarly, María was cognizant of what her students were working on. If she worked with one student, she would remind the rest of

the class to use their reading and listening skills when working with their math buddy.

When a student complained that her math buddy was asleep, María immediately redirected the behavior to the task. Jesús also scored high on this indicator because of his classroom management style. Throughout the observations, I noted a climate of mutual respect between Jesús and his students and among the students. During an interview, Jesús stated, “I want my students to learn and they know that. Also I expect them to respect each other and will not tolerate any behavior that will hurt a student.”

For indicator 4, *the pace of the lesson was appropriate for the developmental levels/needs of the students and the purposes of the lesson*, the teachers scored 3.2, 4.4 and 5. Several of Jorge’s lessons received 2 points for this indicator because the lessons were at a level above the students’ understanding. During a lesson on proportions, students grumbled that the lesson did not follow what they had learned the previous day. Additionally, the students had difficulty following the lecture presented by Jorge. María scored fairly high since she was cognizant of the ELLs in her classroom. In a lesson on fractions, she provided direct translations of cognates such as *fracción* for fraction to assist her language learners. Jesús was also conscious of the needs of his second language learners. When he noticed some of his students having difficulty with the English language, he completely translated the problem on fractions.

Indicator 5, *the teacher was able to “read” the students’ level of understanding and adjusted instruction accordingly*, also averaged mean of 3.2, 4.2, and 4.8. On this indicator, Jorge scored average because the same set of students was often not engaged in the lesson. In some instances, Jorge would ask a student to wake up or stay on task. The students would listen, but would revert to their original stance once Jorge moved away.

María commented that she often reviewed data from the exam to identify content area and skills that needed reinforcement and factors that may motivate student learning. Jesús scored higher than his colleagues on this indicator because he modified his lessons and added information to enhance understanding or to move the students to a more complex concept. Jesús served as a facilitator in his lessons—he laid out the task, and then invited the students to dig into the problems. In a discussion, Jesús explained that several skills were interwoven in a lesson, “When I provide my students with a problem-solving application of mathematics in a real context, I have several purposes in mind: to deepen a student’s understanding of mathematics, to help the student make connections, and to help the student build confidence in himself or herself as a problem solver.”

The mean for indicator 6, *the teacher, where appropriate, used models or manipulatives to demonstrate concepts and/or processes*, was scored as 3.8, 4.2, and 5. Jorge scored above average on this indicator because he often had students using manipulatives and taught abstract, complex words that are critical to understanding the mathematics content. He simplified instructions, and used graphic organizers to allow access of information. These hands-on activities were planned to help students understand the academic language to be learned. María scored fairly high because the lessons were generally connected to a previous lesson and vocabulary was always introduced, reviewed, or reinforced. In a lesson on geometric shapes and fractions, she had students use colored linking cubes for building patterns. In another lesson, she had the words written on sentence strips with the definition on the back and students holding the words acted out the word until the other students provided the correct definition. Jesús began a lesson on ratios and proportional relationships by having students enlarge a

figure using a rubber band stretcher. The students did not use numbers instead looked at the figures geometrically and then moved into solving the problems algebraically. Jesús also used models or manipulatives to demonstrate concepts and/or processes such as the cloze sentences as effective methods for improving vocabulary, syntax, and student understanding of concepts.

On indicator 7, *the teacher's questioning strategies were likely to enhance the development of student conceptual understanding/problem solving (e.g., emphasized higher order questions, appropriately used "wait time." identified prior conceptions and misconceptions)*, the means were 2.6, 4.2, and 4.8. Jorge scored low because he answered the questions he posed and did not allow enough time for students to reflect on the question. In a lesson on frequency tables, he posed the question, "What is your favorite ice cream flavor?" Before the students had an opportunity to answer (5 seconds), he started naming ice cream flavors. María received 4.2 mean because of her practice of using open-ended questions to focus a lesson. In a lesson on probabilities, María began with a line of questioning: *What things could happen in this experiment? What is the probability that this event?* Additionally, she allowed an appropriate amount of time for students to answer her questions as a group. Similar to María, Jesús received high marks in this measure because the use of open-ended questions as a focal point for the lesson. During a discussion on linear equations, slope and y-intercept, Jesús encouraged students to challenge one another's answers by asking questions such as "Does anyone have a different idea? Do you agree with the answer?"

Indicator 8, *the teacher think-alouds technique to narrate the problem-solving process*, was the weakest area (1.4) for Jorge. The other two participants scored 5 and

4.8. Jorge was rated low because the think-aloud strategy was never fully implemented. During one lesson, he began the think-aloud strategy for a problem on proportions but did not complete the strategy thoroughly. María was an expert on the think-alouds technique. She used it often to narrate the problem-solving process. For an activity on numbers, operations, and quantitative reasoning, she took the students through the problem solving by reading the narrative aloud and reflecting on what the problem was asking: “What do they want me to find out? Hmmm... Does Sara have enough money to buy the necklace? How much does she need for the necklace? \$5.00. I’ll write that down here. Ok, she needs \$5.00. How much did she start out with? Oh, \$12.85...” Jesús did not score a perfect score because think-alouds were not observed for every lesson. He did implement a think-aloud during a lesson on proportional relationships to solve multi-step ratio and percent problems. For this lesson he began by reviewing the key terms: “Percent is the same as saying Per 100. For example, if 20 liters out of every 100 liters in a mix are orange juice, then the juice mixture is 20% orange juice.” To connect to a real world problem, Jesús assist his students with a problem on discounted sales price.

Indicator 9, *the teacher used informal language to increase understanding and demonstrate the various thought processes and steps to follow in solving a problem*, was rated higher: 3.6, 4.2, and 4.8. Jorge scored an average mean because his use of informal language enhanced his students’ learning; however, he did not use the Spanish language with his Spanish-speaking students. When a student asked, “Puedemos cortar?” (Can we cut?) about a foldable for a parallelogram, Jorge answered in English “Yes,” as was mandated by the procedures of the dual language program that mandated mathematics classes be taught in English regardless of how much English language proficiency the

students had acquired. María used informal language to help her students understand. She ensured that students understood the different terms that could be used in mathematics problems such as the term *exactly* that can also mean *only*. For the term *mean*, she used the synonym *average*. María reinforced the language with examples such as the batting average for baseball players, the average grade in the class, the average age of students in her mathematics class. Comparatively, Jesús repeated an example on fractions entirely in Spanish. Once the students understood the concept, Jesus continued with the lesson on fractions.

Indicator 10, *the teacher used clarity checks to check for understanding of the task and processes involved before students get started working on the assignment*, was rated 2.8, 4.2 and 5. Jorge' low score was due to the activities that did not connect to the objectives. In one lesson on measurement, Jorge had prepared a TAKS practice worksheet on number lines. On the contrary, María's questioning skills earned her a high score. In a class discussion on probability problems, María asked questions such as: *How did you determine the sample space for this experiment? The sample space is the table you are working with. How did you determine the probability? Another word for probability is the odds. An example is when you buy a lottery ticket. You are playing the odds of winning. That is why not everyone wins.* Jesús earned a perfect score on this indicator because of a method he had taught his students to check their understanding. As his students worked through a lesson on frequency tables, a few students raised their hands and wiggled their fingers. As soon as Jesús noticed he walked to each of the students and assisted them with the assignment.

Indicator 11, *the teacher presented activities that involve application problems in*

contextualized situations; these activities encouraged critical thinking and reasoning along with basic skills development and practice, was rated above average 3.6, 4.2, and 4.8. For this indicator, Jorge's connections to real-life contexts earned an above average score. For lesson 5, Jorge prepared an activity where students were to build two and three-dimensional shapes with cubes. This activity was to enhance students' geometry and spatial perception skills and help them connect math to the physical world. To help the students complete their work, Jorge challenged students with analytical comments such as "How do we build a structure so that each silhouette is identical, or can you reconstruct the structures if they were not labeled?" María also scored above average. In a similar manner, María demonstrated how to solve for perimeter and area of a rectangle with a 15-inch length and a 9-inch width by turning the statement into a question: *Calculate the perimeter and area of a rectangle with a 15-inch length and a 9-inch width into a question: For what whole number values of length and width will the rectangle have an area of 60 square yards and a perimeter of 38 yards?* María shared, "Math content is often taught in ways that force students to use their cognitive abilities." During the introductory discussion on linear equations, slope and y-intercept, Jesús allowed students the opportunity to challenge one another's answers by asking questions such as "Is this correct?" and "Does anyone have a different idea?" After the discussion, the students worked in pairs on plotting. When they completed the assignment, students went to the front of the room and placed pictures on the overhead version of the grid to display their work. Jesús then allowed other pairs to comment on the correctness of the placement.

Indicator 12, *the teacher encouraged the use of diagrams and other visual aids to*

help students develop concepts and understanding, was scored with a mean of 3.5, 4.2, and 5. This indicator was used for measuring whether specific attention was placed on the academic needs of ELLs. For this indicator, Jorge scored a mean of 3.6. For lessons 4 and 5, Jorge had developed activities to help his students think critically. In lesson 5, Jorge had the students interpret shapes in two and three dimensions by building cubes. This activity enhanced the students' geometry and spatial perception skills and helped them connect math to the physical world. After they completed the drawings, Jorge helped them think critically by posing several analytical questions such as "how to build a structure so that each silhouette is identical, or whether they could reconstruct the structures if they were not labeled." In lesson 3 María taught students how to solve a problem through different methods: writing examples and thinking aloud for the problem: *Party balloons cost \$15.00 for four balloons. How much will Mary spend on balloons if she buys a dozen balloons?* "First I need to set up an equation $4/15 = 12/x$. In this equation the 4 represents four balloons and 15 the amount for 4 balloons; 12 represents the number of balloons Mary will buy and x is the cost we are solving for. In a more simplistic method you can list the number of balloons, and the cost of the balloons and add."

$$\begin{array}{r} 4 \text{ balloons} = \$15.00 \\ 4 \text{ balloons} = \$15.00 \\ 4 \text{ balloons} = \$15.00 \\ \hline 12 \text{ balloons} = \$45.00 \end{array}$$

The 5 lessons were rated on the upper end of the scale because of María's attention to the objectives and alignment of activities and resources. While the lessons implemented were difficult at times, they were engaging and captured the students'

attention. At times, she even translated problems to assist ELLs in learning the concepts. The use of real world connections earned Jesús a perfect score for this indicator. During a discussion about symmetry in a real world setting, Jesús presented examples that helped students make connections between symmetry and familiar contexts. Then he continued soliciting students' input of their own examples. He welcomed their ideas and expanded the discussion around each example. For the last 15 minutes of the lesson, students worked on a hands-on activity designed to apply the concept of symmetry. Students were instructed to draw the left side of a Christmas tree (on graph paper), add decorations of their choice, (e.g., half of a star), then exchange with their neighbor and draw the other half of their neighbor's tree.

The acquisition of different types of knowledge, skill, and levels of thinking (Bloom, 1956) requires different conditions of learning (Merrill, 1971) that in turn call for different methods of teaching to produce efficient and effective instruction. It is not a matter of preference what teaching and learning strategies to use to meet a particular set of objectives, but it is a matter of making informed pedagogical choices. The participants took care to always include strategies for literacy and language objectives in the lesson plans.

As a language objective, the participants viewed writing as a tool for learning and often provided opportunities in their lesson for students to write about their observations and understanding and to form connections about mathematical ideas. They supported students in deepening personal understanding through the use of writing and through integrating writing with other learning activities. These teachers used writing as a tool for thinking in three ways. It was initially used to engage students in thinking about prior

knowledge, making current knowledge available for use as a starting point in considering new ideas. Writing was also used in subsequent learning activities as students explored and analyzed mathematical ideas, observed relationships, and wrote their thoughts to clarify, organize, and revisit them. Literacy strategies can enhance learning in two ways. They can increase student opportunities to focus on and practice procedures, increasing awareness of these, and providing additional opportunities to rehearse materials to be learned. An example of writing in the mathematics classroom was the practice of journaling. In an experiment on probability with rolling two dot cubes, María instructed students to describe the results of their experiment in their journals. In their journal, students wrote their comparison of the results with the theoretical probability of rolling a 2 one time out of every 6 rolls. In a warm-up exercise, Jesús' had his students write the following in their journal: *An adult dog gets one teaspoon of vitamins per 20 lbs. of its body weight. Explain how to determine the dosage for an adult dog that weighs 15 lbs.* Jorge used journaling for vocabulary development and as a resource for students to refer to when working with mathematics terminology.

Findings in Classroom Culture

One of the indicators of in classroom culture is an ability to encourage and value the active participation of all students in meaningful discourse in the classroom. High expectations for student behavior are fundamental to creating a positive, productive learning environment.

Table 25
Classroom Culture Ratings of Key Indicators Mean

| | Jorge Mean | María Mean | Jesus Mean |
|--|---------------|---------------|---------------|
| 1. Active participation of all was encouraged and valued | 2 | 4.4 | 4.8 |

| | | | |
|--|-----|-----|-----|
| 2. There was a climate of respect for students' ideas, questions, and contributions. | 4.2 | 4.4 | 5 |
| 3. Interactions reflected collegial working relationships among students (e.g. students worked together, talked with each other about the lesson). | 3.8 | 4.4 | 5 |
| 4. Interactions reflected collaborative working relationships between teacher and ELLs. | 3.6 | 4.4 | 5 |
| 5. The climate of the lesson encouraged ELLs to generate ideas, questions, conjectures, and /or propositions. | 3.6 | 4.4 | 4.8 |
| 6. Intellectual rigor, constructive criticism, and the challenging of ideas were evident. | 3.4 | 4.4 | 4.8 |
| 7. The experiences and cultures of ELLs are valued. | 3.4 | 4.4 | 5 |
| 8. ELLs are allowed to record answers or solution steps in their own native language. | 3.6 | 4.4 | 5 |
| 9. Focus is placed on the meanings ELLs are conveying instead of on grammar and usage. | 3.6 | 4.4 | 5 |

Table 25 above presents the mean for each indicator in the Classroom Culture Rubric for each participant. Indicator 1, *active participation of all was encouraged and valued*, was rated as a mean of 2, 4.4, and 4.8. Jorge was rated low because of the lack of high expectations for all his students. Often some of Jorge's students were off task. Even after being redirected, the students would leave the task, as soon as Jorge turned his attention elsewhere. For María, classroom culture was rated high because there was an encouragement of active participation of all in the activities of the day. During a lesson on fractions, all students raced to be the first to solve the following equations: *Complexity=3, Mode=improper, Subtract each pair of fractions and simplify the result, $3/2 - 1/2$ and $4/5 - 1/3$* . To motivate her students, María promised them they could read during the last 5 minutes of the class period, if they participated in solving the equations. Jesus scored high on this indicator because of his compassion for his students. In one particular instance, a student was having difficulty remembering how to solve a problem on ratios. Despite the fact that other students wanted to answer, Jesús ensured they

allowed the student time to answer the question. With this method, Jesús facilitated that all students participate in the collective activity and signaled that all thoughts were worthy of expression.

Indicator 2, *there was a climate of respect for students' ideas, questions, and contributions*, was the highest rated indicator: 5, 4.2, and 5. Jorge's mild mannered nature was inviting and his compassion for his student was often evident. During one of the lessons, a student asked him why he had called his parents. Jorge had called the parent to provide positive comments about the student's work in classroom assignments. The exchange between Jorge and his student provides evidence of his caring and the friendly learning environment he had created in his classroom. María established a climate that encouraged all students as well as ELLs to generate ideas, questions, conjectures, and /or propositions. In a lesson on fractions, the students were to work in pairs, complete the equations, and then present their findings to the group. María established the rules by announcing that no one was to laugh if a group had the wrong answer. Instead students were to help the pair obtain the correct answer with constructive comments. Similarly, Jesús believed that all his students could learn mathematics despite the language obstacles they faced. To help his students meet his high expectations, he expected his students to take responsibility for their own learning, and he provide the increased support necessary to help students meet these higher standards by encouraging them to participate in class discussions and problem solving.

For Indicator 3, *interactions reflected collegial working relationships among students (e.g. students worked together, talked with each other about the lesson)*, all three participants were rated above average with a mean of 3.8, 4.4, and 5. The students in

Jorge's classroom often worked with each other on the activities presented. For a lesson on frequency tables, students worked in pairs as was indicated on the language objective: "the student will write, discuss, analyze, use partner talk, class talk and group work." However, he reminded students that they had to participate in the group work to receive a grade. In María's classroom, students sat at desks in row formations and worked with their math buddies. The students were aware of the rules and knew that they were to respect each other's work. Jesus also received a high mean. Jesús seemed to know his students well and was easily able to get all students participating by calling on both volunteers and non-volunteers. Both the teacher and students were respectful of each other's thoughts. Discussions were lively and included multiple students' perspectives. Jesús had an ability to naturally adjust instruction based on students' level of understanding and the degree of "sense-making" within the lesson.

Indicator 4, *interactions reflected collaborative working relationships between teacher and ELLs*, was rated as 3.6, 4.4 and 5. Jorge strived to connect with the ELLs in his classroom. During several lessons, Jorge worked at engaging students in meaningful activities from the first minute of class and continued to engage them throughout the lesson. María applied several think-aloud procedures in preparing students for understanding the problem-solving steps. Additionally, she employed a modeling strategy for an activity on fractions: "first, I need to factor the numerator with the denominator to the lowest number, next, I need to..." María applied strategies so that all her students learned the mathematics concepts and ensured that ELLs learned as well as all native English speakers. In Jesus' classroom, students had mathematical conversations and were able to state their thoughts with confidence. For example, students knew it was okay to

say what they thought, and it was also okay to disagree and change their minds. Jesús' classroom demonstrated a way to honor the process of developing mathematical understanding in students.

Indicator 5, *the climate of the lesson encouraged ELLs to generate ideas, questions, conjectures, and /or propositions*, had a mean of 3.6, 4.2, and 4.8. In Jorge's classroom, there was a climate of respect for students' ideas, questions, and contributions; however, the participant seemed to have difficulty with extending students' comments and questions to align with the lesson. In a lesson on proportional reasoning to solve problems, students had a difficult time understanding Jorge's questions. While Jorge asked students questions about the lesson and repeated the questions differently several times, there was little response time allocated between the questions, and students failed to respond. As the observations progressed, Jorge learned to adjust the response time allowed for students to answer questions. In contrast, María often implemented multiple strategies designed to assist her students in learning mathematics concepts. At times, María used a traditional approach of giving examples on the whiteboard, after which students practiced the skill. Other times, she engaged students in active problem solving that focused on developing mathematical understanding, presenting mathematics in context, and encouraging communication about mathematics. During a lesson on linear equations in Jesús' classroom, I noticed an extraordinary amount of excitement, and the fact that the content was rigorous. I documented that the classroom culture was phenomenal. Jesús often facilitated a safe learning environment for all students to participate. His promotion of collective responsibility in the classroom community was evident by utterances such as, "Could someone help Elsa, what is Elsa trying to say?" He

also encouraged silent students to participate by asking their opinions, “Antonio do you agree?” Jesús’ value of his students was often expressed with statements such as “very good question; or does anyone have any other ideas?” In other instances, it was clear that Jesús set the tempo of interaction in the room.

Indicator 6, intellectual rigor, constructive criticism, and the challenging of ideas were evident 3.4, 4.4, and 4.8. For one lesson on measures of central tendencies, mean, medium, mode, and range, Jorge allowed students to challenge each other’s ideas on the posters they worked on. While the students worked, Jorge walked through the classroom and provided students with constructive comments on their work. In a similar way, María encouraged her students to investigate a problem and to determine and present a solution. While discussing a word problem, María asked one student to interpret a problem and then another student to rephrase the problem in his own words. Jesús added intellectual rigor and challenged his students. In a lesson on frequency tables, students worked in dyads to solve a problem on the number of peaches sold by a vendor within 3 hours. To help his student understand the concept, Jesús drew a table on the Promethium Board and asked volunteers to explain each step of the problem. Each student was allowed a few minutes to work on his own before presenting his findings. When the first student presented the following: *first find the number of vendors that sold at least 16 peaches = the number of vendors who sold 16-20 peaches + number of vendors who sold 21-25 peaches = 16 + 1 = 17*, Jesús asked the class if the information was correct. This routine was followed until the frequency table was complete. In between student presentations Jesús conducted a clarity check before continuing.

Indicator 7, *the experiences and cultures of ELLs are valued*, was rated 3.4, 4.4,

and 5. Jorge's awareness of ELLs progressed throughout the observations. In a lesson on mode and median, he worked with an ELL, Janie. To help Janie span the language barrier, he included elements of direct instruction, telling, and explaining. These strategies were implemented less often with his other students for whom he challenged with probing questions. When elements of Janie's own thinking were visible Jorge praised her for her efforts. María, as well, was empathetic of her students' lack of English proficiency. She helped them develop academic language as often as she could. In a lesson on geometric solids, she had the students find examples in their every days lives from magazines and newspapers or from around their house. Jesús scored a perfect score because he was cognizant that in addition to having to build their oral English skills, his students also needed to acquire reading and writing skills in English, while simultaneously learning in mathematics. To Jesús it was important that his students learn the English language but not at the expense of their native language, so he often translated words, phrases, and entire problems. He also seemed to have a strong understanding that representing information in non-linguistic ways is also an important consideration. Jesús commented, "Sometimes, I make changes to help my students understand mathematics concepts. For example, the idea of slope can be expressed using graphs of lines, algebraic symbols and formulas, tables of values, or with contextual information (e.g., the fixed cost of an item is the slope of a cost function for that specific item)."

Indicator 8, *ELLs are allowed to record answers or solution steps in their own native language*, received above average means of 3.6, 4.4, and 5. While Jorge did not speak Spanish in the classroom, he did allow his students to use their native language

when computing mathematic equations. The students in Jorge's classroom often felt comfortable using their home language in the classroom. Students not only used native language when discussing the problems with their peers, they used the language when they worked on their own. During two lesson implementations, María had established a positive classroom environment, had students paraphrase directions, ensured that all students were engaged in the lesson, varied whom she called on and was aware of her teaching tempo. These lessons were rated high because of the methods in which María presented the content to the students. María introduced the purpose of the lessons and related the objective to the students' lives. On several occasions, I documented that Jesús spoke to his students in Spanish and allowed them to converse in Spanish while problem solving. When asked why he allowed his students to have discussions in Spanish, Jesús commented that students needed to use their first language to learn the concept and then learn the English academic language. Jesús allowed his ELLs to learn both the language and content together.

Indicator 9, *focus is placed on the meanings ELLs are conveying instead of on grammar and usage*, was evaluated at a mean of 3.6, 4.2, and 5. The language objective frequently directed to students to use writing for learning mathematics concepts. Jorge implemented writing and graded it for content rather than on grammar or English usage. The students in Jorge's classroom worked in pairs or groups, used manipulatives, note taking, and developed their own graphic organizers for academic vocabulary. Similar to case study 1, María often implemented writing as part of the language objective. In a lesson on probabilities, María instructed her students to write a paragraph on the probabilities of their football team winning a football game during the season based on

their winnings the previous year. In a similar fashion, Jesús asked his students to write about specific problems. For example, students were instructed to explain a frequency table on classroom grades where 4 students had scored below 75, 14 scored between 76-80, 2 scored between 81-85, 8 scored between 86-90, 5 scored between 91-95 and 1 scored between 96-100. This assignment had at least five steps so the teacher allowed students to begin in class and finish at home. Like Jorge, Jesús graded the assignment on content and do not deduct points for grammar and language usage.

Findings in Teacher Mathematics Academic Background

Data for the first part of research question 2 *what effect does the academic background and professional development of mathematics teachers have on the academic achievement of second language learners*, was obtained through a participant questionnaire, from interview notes, and from archival records such as college transcripts.

In some cases, teachers' backgrounds influence their selection of strategies implemented in the classroom. For example, pre-service preparation may contribute to teachers' comfort with various pedagogical practices. Similarly, the extent of teachers' experience, or lack of experience, may lead them toward the use of particular strategies. Finally, the teachers' own experience as a mathematics learner sometimes proves an influential factor in instructional decisions.

Based on the definition of a highly qualified middle school mathematics teacher—the completion of coursework equivalent to at least a minor in mathematics for middle school (NCTM, 2005)—the three participants in this cross case analysis were highly qualified to teach their assignment. Jorge was in his sixth teaching year with a bachelor's in electric engineering, had completed an alternative certification program,

and was certified to teach mathematics in grades 4-8. María had a bachelor's degree in education with a minor in mathematics, and like Jorge was certified to teach mathematics in grades 4-8. Jesus had earned a bachelor's in secondary mathematics, and was certified to teach high school mathematics.

Both María and Jesus had participated in student teaching prior to being hired by the district and noted that their pre-service preparation has led to their perceptions of how students learn best and their comfort with the pedagogical strategies they use. They described a number of different pedagogies that were addressed in their pre-service experiences, indicating that they used what they had learned in the observed lessons and more generally: hands-on approaches, lecture, questioning to guide learning, and the use of multiple strategies. Jesus indicated that he had had a constructivist model at the university he attended and had been given lessons and information on discovery and inquiry. Therefore, he was very comfortable with this type of instruction.

Jorge also exhibited the same comfort level with pedagogical strategies as his colleagues. However, Jorge was part of an alternative certification program that allowed for teachers to teach while they take classes on pedagogy. Jorge liked exploration type of instruction, but he felt that often his students needed more structure and planned his lesson accordingly. Jorge did lack the experience of his colleagues and it became evident in the lesson planning and implementation. He lacked the skills to implement other approaches and often selected more structured pedagogical strategies such as teacher lecture.

Quality teaching at all levels ensures that mathematical discussion is not simply a time filler but is focused instead on the solution of a genuine mathematical problem. The

most productive discourse is that which allows students to access important mathematical concepts and relationships, to investigate mathematical structure, and to use techniques and notations appropriately. Research provides sound evidence that when teachers employ classroom discourse for these purposes over sustained periods of time, they provide students with opportunities for success, they present an appropriate level of challenge, they increase students' sense of control, and they enhance students' mathematical disposition (Moschkovich, 2007).

Although the research is not definitive, studies indicate a trend toward a positive relationship between secondary teachers' subject knowledge and student achievement, particularly in mathematics (Bolyard, 2008). Secondary teachers who hold a bachelor's or master's degrees in mathematics appear to have positive impacts on student achievement.

Teacher coursework in mathematics also appears to have a positive impact on student achievement, although at least one study found the impact diminishes after a particular number of courses and differs depending upon the level of course (remedial vs. advanced) in mathematics.

An examination of college transcripts of the three case studies provided a clear picture of courses that had been taken by the teachers. Results of the transcript examination are presented in Table 26. Because of a minor, María had only taken 12 additional hours of advanced coursework. Jorge's transcript demonstrated thirty-six hours of highly advanced mathematics classes; however, the classes focused on engineering and not on application. Jesus's course study required thirty-six hours in mathematics of which thirty hours were advanced classes. Because, he had chosen the certification track, his coursework reflected classes with mathematics applications. The fact that both Jorge and

Jesus majored in engineering and mathematics ensured that a member of the mathematics and/or engineering department taught mathematics content courses. However, for María mathematics methods courses were likely taught by education school faculty and typically cover the use of manipulatives and other representations for content, problem solving, classroom organization, and designing and teaching math lessons.

Table 26
College Mathematics & Pedagogy Coursework

| Participant | Major | Minor | Basic Mathematics | Advanced Mathematics | Pedagogy |
|-------------|------------------------|-------------|-------------------|----------------------|----------|
| Jorge | Electronic Engineering | Mathematics | 6 | 36 | 0 |
| María | Elementary Education | | 6 | 12 | 18 |
| Jesus | Mathematics | Biology | 6 | 36 | 18 |

All three participants were mathematics teachers; however, each had taken a different path toward becoming a mathematics teacher. While Jesus held a major in mathematics and María a minor, both had taken the education track and had completed student teaching requirements prior to becoming teachers. On the hand, Jorge had opted to obtain a degree in engineering and had become a teacher through the alternative certification program; therefore had not taken coursework in pedagogy. Additionally, the kind of math Jorge studied was quite different than the math he taught. Further, Jesus and María received better training in pedagogy, so the lack of pedagogy training for Jorge probably also contributed to the lower scores his students received. Of the three participants, Jesus had the highest student achievement rate. Teachers' content knowledge for teaching mathematics was a significant predictor of student gains in both models at both grade levels. This suggests that the effect of teachers' knowledge on

student achievement is at least content specific and that, in mathematics, it reflects more than simply general knowledge of teaching.

Findings in Mathematics Teacher Professional Development

To answer the second section of research question 2 *what effect does the academic background and professional development of mathematics teachers in this cross case study have on the academic achievement of second language learners*, I gathered the data needed through a questionnaire on professional development attended by each teacher. Additionally, I conducted interviews to gain additional information and verify what I found in the lesson plans, lesson observations, and archival data.

The *Professional Standards* on effective professional development and training for teachers include experiences that model good mathematics teaching, develop knowledge about mathematics, mathematics pedagogy, and students, and facilitate the continued development of teachers' practice. Professional development for mathematics teachers often focuses on the development of pedagogical skills. The three case studies attributed their selection of instructional strategies, at least in part, to their professional development activities. They reported that professional development sessions they attended introduced them to a particular pedagogy, or reinforced strategies that they were already using in their lessons.

Based on the type of professional development sessions listed Table 25, it was clear that the three teachers had numerous staff development opportunities. While the teachers were not required a certain amount of hours of staff development, they participated in most of the sessions offered by the district and often attended the sessions together.

Table 27 presents a comparison of the professional development sessions attended by the three participants. The sessions listed are very similar since the three participants often attended the same trainings. Of the content-focused and teaching methodologies or pedagogy professional development, Jorge attended the most sessions. María attended the most sessions on strategies for teaching ELLs. Overall, Jorge attended the most sessions, 18, María attended 16 sessions and Jesus attended the least, 14. An emerging body of work suggests that professional development that focuses on both subject-matter content and how students learn that content may be an especially important element in changing teaching practice (Desimone, Smith, and Ueno 2006).

Table 27
Professional Development Types

| | Mathematics Content | Other (teaching methodologies or pedagogy) | Strategies for English Language Learners |
|-------|---------------------|--|--|
| Jorge | 7 | 6 | 5 |
| María | 5 | 4 | 7 |
| Jesus | 4 | 5 | 5 |

To find a correlation between mathematics teacher academic background and professional development sessions attended, I used student proficiency levels from the seventh grade TAKS scores. The student proficiency levels indicate that the teacher's background did have an impact on student achievement. Table 28 below presents the student results on the mathematics TAKS. With a minor in mathematics, María had the lowest success rate with 20% of her ELLs reaching proficiency on the exam. Despite his degree in a different type of mathematics (engineering), Jorge's students earned a passing rate of 40%.

Table 28
Student Demographics & Texas Assessment of Knowledge & Skills Results

| | Economically Disadvantaged | LEP | All Student % Met Standard | LEP % Met Standard |
|-------------------|----------------------------|-------|----------------------------|--------------------|
| Campus | 92.7% | 33.6% | 74% | 63% |
| Jorge's Classroom | 100% | 42% | 47% | 50% |
| María's Classroom | 100% | 26.3% | 52.6% | 20% |
| Jesús' Classroom | 81.8% | 16% | 100% | 100% |

The highest proficiency rate belonged to Jesus's students. Of the three participants, Jesus was the only with a degree and certification in secondary mathematics.

Conclusion

The main focus of this case study was to investigate the instructional practices middle school mathematics teachers use in classes with English Language Learners; how the different practices result in differential student achievement; the types of professional development middle school mathematics teachers participate in that are designed to help them more effectively teach English language learners; how these teachers incorporate strategies learned from professional development into their lessons; and what effect the academic background of mathematics teachers has on the academic achievement of second language learners.

To answer the research questions, I conducted case studies of three 7th grade mathematics teachers. For each case study, I reviewed five separate lesson plans, evaluated the implementation of the lessons, and interviewed the teachers to obtain additional information. The majority of the lessons were from the district-adopted curriculum, CSCOPE, but at times the teachers altered the plans to meet the needs of the students in the classrooms. Lessons included topics such as equations, proportionality,

number operations, measurement and relationships and expressions. The lesson plans and implementations provided data for the first research question: *what instructional practices do middle school mathematics teachers use in classes with ELLs* and sub-question: *how do the different practices result in differential student achievement between mainstream students and ELLs?* Additionally, I conducted interviews to gain additional information and verify what I found in the lesson plans, lesson observations, and archival data.

Data for the first part of the research question 2 *what effect does the academic background and professional development of mathematics teachers in this cross case study have on the academic achievement of second language learners*, was obtained through a section of the participant questionnaire, during interviews, and from archival records such as college transcripts as well as from archival data on student test scores.

To answer research question 2, *what effect does the academic background and professional development of mathematics teachers in this cross case study have on the academic achievement of second language learners*, I gathered the data needed through transcripts, school district archival files and a questionnaire on professional development attended by each teacher.

Chapter 6 will begin with a brief summary of the research study, including the data collection, participants and setting, and background. Then I provide a summary of the findings presented Chapters 4 and 5. From there, I will draw conclusions based on the findings for the three research questions and their related sub-questions. Next, I will consider implications of these conclusions. I will end by considering what areas of this research should be considered for further study.

CHAPTER 6: DISCUSSION AND CONCLUSIONS

Background

English Language Learners (ELLs) are the fastest growing segment of the public school population. Between the 1997-98 school year and the 2008-09 school year, the number of English-language learners enrolled in public schools increased from 3.5 million to 5.3 million or by 51 percent (National Clearinghouse for English Language Acquisition, 2011). During the same period, the general population of students grew by only 7.2 percent, to 49.5 million. The burgeoning numbers of English-language learners pose unique challenges for educators striving to ensure that these students get access to the core curriculum in schools and acquire academic knowledge, as well as English-language skills. Additionally, two-thirds come from low-income families and three out of four ELLs are Spanish-speaking (National Clearinghouse for English Language Acquisition, 2011). A key concern for educators of English language learners is that their academic performance is well below that of their peers and that ELLs have excessively high dropout rates.

Problem

Achievement data suggest that English-language learners lag far behind their native English speaking peers. Nationwide, only 12 percent of students with limited English proficiency scored at or above proficient in mathematics in the 4th grade on the 2009 National Assessment of Educational Progress (NAEP), compared with 42 percent of students not classified as English-language learners. The gap was considerably wider in 8th-grade math, where 5 percent of ELLs were proficient or above on the 2009 NAEP, compared with 35 percent of non-ELL students.

On the NAEP reading test, the percentages of limited-English students who reached proficient was lower than for the math test in both 4th and 8th grades. Only 3 percent of ELLs met that standard in 8th grade reading in 2009, compared with 34 percent of non-ELLs. These national trends in both reading and math are a concern for educators.

A similar trend can be found at the state level where the Texas Assessment of Knowledge and Skills (TAKS) assesses the content areas of students in grades three through eleven. Analysis of the 2010 seventh-grade mathematics TAKS, revealed that ELL's school performance is far below that of other students, oftentimes ten to twenty percentage points. While the ELL group has made gains since the first administration of the TAKS mathematics exam, the gap between this subgroup and other student subgroups has not narrowed. As a group, students classified as ELLs perform consistently lower on the Texas Assessment of Knowledge and Skills (TAKS) than any other group of Texas students.

English Language Learners (ELLs) are, from the time they enter a U.S. public school, challenged not only to learn a new language in a relatively short time span and learn and master the content of the core disciplines in English, they must pass state-wide high stakes tests at periodic points along their educational career and at the end of their educational career in order to receive a high school diploma. The challenge for teachers and administrators is to provide a positive learning environment that successfully maximizes the learning experiences of ELLs and provides them access to the opportunities for other educational experiences and meaningful participation in the democratic experience.

The increasing number of second language students combined with new standards and standardized testing has changed the dynamics in the mathematics classroom. Schools and teachers that serve second language learners must not only identify and use instructional strategies that make content more accessible in a second language, but also consider how to implement culturally relevant pedagogy in mathematics classrooms. Mathematics teachers must now impart more challenging mathematical concepts while many students are simultaneously learning English. Principles and Standards for School Mathematics (NCTM 2000) emphasize communication “as an essential part of mathematics and mathematics education.” It is important for all students, but especially critical for ELLs, to have opportunities to speak, write, read, and listen in mathematics classes, with teachers providing appropriate support and encouragement.

Campbell, Adams, and Davis (2007) and Draper and Shiebert (2004) and Kabasakalian (2007) contend that part of the reason for the low performance of ELLs has been the lack of teacher preparation on appropriate methodologies for teaching second language learners. Teaching mathematics to students who are simultaneously learning English has created specific difficulties for mathematic teachers. The challenges faced by ELLs in mathematics classes are exacerbated by the fact that only about 15% of secondary school math teachers have specific training in working with students who are not proficient in English (Combs, Evans, Fletcher, Parra, & Jimenez, 2005; Coates, 2006).

As the number of Ells has increased, the number of teachers trained in second language acquisition pedagogy has declined (Freeman & Crawford, 2008). Data from the 2002 National Center for Education Statistics showed that 41% of teachers have ELLs in

their classes, yet less than 13% of those teachers have had 8 or more hours of training in second language pedagogy. The increase of ELLs in U. S. schools combined with poor performances on international, national, and state mathematics standardized tests suggest that greater attention on how mathematics content is taught to ESL students is needed (Holmes & Duron, 2000; MacDonald, 2004).

Setting and Participants

The present cross-case study was designed to determine the effect of instructional practices middle school mathematics teachers use with English language learners in their classes; how the different practices result in differential student achievement; the types of professional development middle school mathematics teachers participate in to help them teach English language learners effectively; and the effect the academic background of mathematics teachers has on the academic achievement of second language learners.

This cross case study included observations of and interviews with three seventh-grade mathematic teachers in a South Texas middle school in the United States. The three participants were of Hispanic ethnicity, María had 25 years of experience while Jesus had taught for 21 years and Jorge had six years in the teaching field. The participants' career experiences were similar with all three having worked at the same middle school and having taught mathematics for their entire teaching career. Of the three, one participant was certified to teach high school mathematics; the other two were certified to teach middle school mathematics.

Data Collection

The main sources of data for this cross-case analysis were classroom observations, interviews, questionnaires, archival data on student test scores and on the

academic and teaching background of the teachers, the type of professional development the teachers attended, and teaching artifacts. Data, including interview notes, lesson plans, lesson observations, records of teacher professional development, and mathematics academic background, were used to link factors in the classroom to student achievement. Teacher background was obtained from school records, college transcripts, and questionnaires. The data was analyzed to determine the nature and quality of the lessons, the intellectual engagement of the students, and the effectiveness of lesson implementation, content, and classroom culture (Nasir, Hand, and Taylor, 2008).

Summary of Findings

The following sections summarize the findings from each data source: the lesson plans, lesson observations, mathematics academic background and professional development.

Lesson Plans Findings

Five lesson plans obtained from the teachers as part of the district-adopted *CSCOPE*, a curriculum developed by a team of Regional Educational Service Centers, were reviewed for this cross-case study. The lessons were complete with formal objectives, activities, manipulatives, and scripts for teachers to use if needed.

The three participants often worked in partnership when writing the lesson plans, for the lessons were shared by the three. The three teachers planned the lessons collaboratively and often supplemented the lessons with resources they had obtained from the campus or workshops they had attended. In planning the lessons, the objectives were defined as in the *CSCOPE* curriculum; however, the teachers added language objectives and at least one Common Instructional Frameworks (CIF) strategy.

While the three teachers used the same source for the lesson plans and planned together, they each made additions and deletions that resulted in more or less effective lesson plans. To rate each of the 5 lessons observed, I used the *Lesson Plan Rubric* (Appendix B). The rubric was designed to appraise each lesson based on 10 indicators.

The quality of the mathematics content of the lessons was rated based on its importance in 7th grade mathematics and its appropriateness for the particular students in the class, particularly ELLs. The three participants selected content based on characteristics of the students, particularly those of their English language learners. Most often in these situations, the teachers picked content geared to address the ability levels of their students. Jesus and María selected content that was at a level the students could understand and scaffolded more difficult concepts once the students had mastered the basics. However, they were cognizant that the lessons had to be challenging and had to motivate students to learn. Jorge also chose content that was part of the seventh grade curriculum; however, at times the lessons seemed to be beyond the students' comprehension.

Table 29 shows the average mean for each teacher's lessons based on the rubric with 5 being the best and 1 being the lowest. Jesus' mean was higher than Jorge and María's means because his lesson plans contained more of the elements necessary for an effective lesson. The ratings for each of the indicators varied from teacher to teacher. The highest scores were those of Jesus while the lowest were Jorge's scores.

| Table 29 Lesson Plan Mean | | |
|------------------------------|-----------------------|-----------------------|
| Jorge Mean Average | María Mean Average | Jesus Mean Average |
| 3.64 | 4.12 | 4.8 |

Lesson Implementation Findings

To rate the implementation of the lessons, I used the *Lesson Observation Rubric* (Appendix C) with 12 indicators. After rating the lesson plans, I observed each of the five lessons to determine how well each teacher applied the instructional strategies. As shown in Table 30, the quality of lessons the teachers designed and taught to help English language learners learn mathematics content while simultaneously learning language varied considerably among the three participants. Jorge's implementation of the lessons at times did not match the lesson plan, and that seemed to confuse the students. María did follow the lesson plan, but did not offer the flexibility of her colleague, Jesus. Jesus used the lesson plan as a guide and adjusted his lesson to his students' needs as he taught. Of the three teachers, Jorge had the least effective implementation and Jesus scored the highest mean in the lesson implementation rating.

Table 30
Lesson Implementation Mean

| Jorge Mean | María Mean | Jesus Mean |
|------------|------------|------------|
| 3.26 | 4.4 | 4.8 |

Findings from Classroom Culture

Data for this section were obtained by rating each lesson using the *Classroom Culture Rubric* (Appendix D). The rubric was designed to appraise each lesson plan, as it was implemented based on 9 indicators. Important content and well-designed tasks at an appropriate developmental level are essential in order for students to have an opportunity to learn. So too is a classroom culture conducive to learning, one which is both rigorous and respectful. As indicated in Table 31, the lessons received high ratings for having a climate of respect for students' ideas, questions and contributions. Ratings for intellectual

rigor, constructive criticism, and evidence of challenging of ideas were given a higher rating. Some of the lessons were highly respectful and encouraged students to engage in serious learning. However, some of the lessons observed were not as motivating, thus the differences in how they were rated.

Table 31
Classroom Culture Mean

| Jorge Mean Average | María Mean Average | Jesus Mean Average |
|-----------------------|-----------------------|-----------------------|
| 3.5 | 4.4 | 4.9 |

The findings in Table 31 above demonstrate that all participants created a welcoming and nurturing environment for students to learn in. Both María and Jesus and, to some extent, Jorge ensured that students were intellectually engaged with the mathematics content, and monitored student understanding as the lesson progressed. Additionally rather than assuming that students will forge that understanding on their own, the participants assisted their students in making sense of the mathematics concepts being addressed.

A pattern of differential quality of instruction across the participants was revealed during the observations. While María's lessons were high in quality, the culture in the class was at times tense, and I noted that students sometimes hesitated to express their views. In contrast, Jorge's classroom was almost too relaxed in that a few students actually fell asleep. In Jesus' classroom the students were continuously engaged in learning.

Findings from Mathematics Teacher Academic Background, Professional Development

Table 26 from Chapter 5 illustrates the academic background of each participant. All three participants had taken a different path toward becoming a mathematics teacher. While the three participants had some type of mathematics background (electrical engineering major and mathematics minor) only Jesus had a degree in secondary mathematics. Two participants, Jesus and María had taken coursework in pedagogy and had completed student teaching requirements prior to becoming teachers. The third, Jorge, had been part of an alternative certification program and taught as he learned pedagogy.

Table 26
College Mathematics & Pedagogy Coursework

| Participant | Major | Minor | Basic Mathematics | Advanced Mathematics | Pedagogy |
|-------------|------------------------|-------------|-------------------|----------------------|----------|
| Jorge | Electronic Engineering | Mathematics | 6 | 36 | 0 |
| María | Elementary Education | | 6 | 12 | 18 |
| Jesus | Mathematics | Biology | 6 | 36 | 18 |

Professional development for teachers is a key mechanism for improving classroom instruction and student achievement (Ball & Cohen, 1999; Cohen & Hill, 2000; Corcoran, Shields, & Zucker, 1998; Darling-Hammond & McLaughlin, 1995; Elmore, 1997; Little, 1993; National Commission on Teaching and America's Future, 1996).

Professional development for mathematics teachers often focuses on the development of pedagogical skills, and the three participants of this study attributed their selection of instructional strategies, at least in part, to their professional development activities. The three reported that courses they had taken or professional development sessions they had attended introduced them to a particular pedagogy or reinforced

strategies that they were already using in their lessons, including the use of manipulative/hands-on activities, cooperative learning, small group work, cognitive coaching and other strategies aligned with brain theory research. The three participants attended different numbers of hours of professional development types as noted in Table 32 below.

Data for the teachers' mathematics academic background and professional development were obtained from school records, college transcripts, and questionnaires.

The data was analyzed and used to link teacher academic background and type of professional development attended to student achievement.

Table 32
Professional Development Hours by Type

| | Mathematics Content | Other (teaching methodologies or pedagogy) | Strategies for ELLs | Total Hours |
|-------|------------------------|--|------------------------|----------------|
| Jorge | 42 | 36 | 30 | 108 |
| María | 30 | 24 | 42 | 96 |
| Jesus | 24 | 30 | 30 | 84 |

Table 32 indicates that Jorge attended more sessions than the other two participants. At first glance, the number of sessions could be explained by the fact that less experienced teachers are generally required to attend more sessions than seasoned teachers. However, in examining the number and type of professional development sessions attended by Jorge, it was noted that he attended more sessions because he taught two different preparations: seventh grade mathematics and Algebra 1 while the other two participants taught only seventh grade mathematics. María and Jesus attended 96 and 84 hours respectively. The variance in number of professional development hours between

María and Jesus is grounded on several factors obtained from participant questionnaires and interviews. The differences were due to illness when one could not attend a workshop or to personal choices of tutoring students rather than attend professional development. However, there was no indication of a correlation between professional development and student achievement.

The teachers' academic backgrounds were linked with the TAKS proficiency rates of the all student subgroup and the ELLs in the teachers' classrooms. Table 28 from Chapter 5 demonstrates proficiency rates by subgroups for the campus and each of the participants. Jesus' students had 100% passing rates while the ELLs in María and Jorge's classrooms had proficiency rates of 20% and 50% respectively. As indicated in Table 28, Jesus had the highest student achievement rate. Data in Table 28 suggests a positive relationship between having a math major in mathematics and coursework in pedagogy and student test scores.

Table 28
Student Demographics & Texas Assessment of Knowledge & Skills Results

| Participant | Economically Disadvantaged | LEP | All Student % Met Standard | LEP % Met Standard |
|-------------------|----------------------------|-------|----------------------------|--------------------|
| Campus | 92.7% | 33.6% | 74% | 63% |
| Jorge's Classroom | 100% | 42% | 47% | 50% |
| María's Classroom | 100% | 26.3% | 52.6% | 20% |
| Jesús' Classroom | 81.8% | 16% | 100% | 100% |

Conclusions

The following conclusions are drawn from the findings summarized in the previous section. The conclusions are grounded on the overall results of the analysis of

the lesson plans, observations/lesson implementation, classroom culture, professional development, and mathematics teacher academic background.

Mathematics teachers who adapt lessons to the needs of their students develop lessons that result in higher student achievement

The lessons obtained from the teachers were part of the district-adopted *CSCOPE*, a curriculum complete with formal objectives and activities developed by a team of Regional Educational Service Centers. However, the curriculum did not contain language objectives. An analysis of the lessons provided evidence that the participants added or deleted as they felt the need to reach their students. Additionally, the participants were aware of the importance of literacy and designed lessons with the inclusion of strategies for literacy with at least one language objective. Each teacher implemented the inclusions of literacy strategies in varying degrees. This variance in instructional strategies correlated with differential student success.

This conclusion is supported by the findings from research question one *what instructional practices do middle school mathematics teachers in this cross case study use in classes with ELLs* and the sub-question: *how do the different practices result in differential student achievement?* In reviewing the lessons, a link between modification of lessons to the needs of their diverse students and student achievement became apparent. For example, the planning of classroom activities that were appropriately developmental for ELLs in the classroom required the selection of materials and format to create an environment that promoted meaningful learning and all levels of thinking. The three participants selected content based on characteristics of the students, particularly those of their English language learners. The selection of content led to the conclusion that when teachers select content that is at a level the students understand and

scaffold more difficult concepts students have more success academically with mathematics. Experienced teachers who know both their content and effective instructional strategies tend to produce higher achievement outcomes among their students. Rowan, Correnti and Miller (2002), among others, have documented significant positive effects of teaching experience on student outcomes. Research suggests that teachers can make the difference for many students, including those who come from disadvantaged backgrounds (Wenglinsky, 2002). Additionally when teachers do not include strategies that engaged diverse students, students did not acquire the academic language or learn the content of mathematics.

Teachers who draw on students' first language and culture create a more conducive learning environment

Data from the observations of the lessons led to the second conclusion. This conclusion also responded to research question and sub-question one, *What instructional practices do middle school mathematics teachers in this cross case study use in classes with ELLs?* and the *sub-question: How do the different practices result in differential student achievement?*

All three participants received above average cumulative scores for the five lessons they implemented. Some high quality lessons were “traditional” in nature, incorporating the use of lectures and worksheets; yet, most of the high quality lessons involved students in more open-ended inquiries. Some of the lessons rated extraordinary were those that included strategies for English language learners to process the operations involved in the mathematical equation and gave them an opportunity to think through how to solve the equation. For example, Jesus helped students translate numbers and symbols into words. The three teachers implemented strategies to increase students’

proficiency in using academic language in the math classroom. Teachers who help students read the symbolic language of math by translating it into natural language help students achieve higher proficiency.

Teachers who create a respectful and challenging learning environment that assists students in learning promote academic achievement

The teachers whose lessons were given higher scores showed respect for their students by drawing on their language and culture. One method was the use of the students' home language in solving mathematical equations. While there has been much debate on which language should be used as the primary language of instruction, English or the child's home language, two of the participants were adamant that the home language must be used particularly with recent immigrant students. Research shows that students' home languages can play an important role in their science and math learning, whether or not the teacher speaks these languages. When students are allowed to use their home language in the classroom, their academic performance as well as English-language development often improves (Kang & Pham, 1995; Latham, 1998).

It can be especially helpful to younger students to use their home language in academic learning. This can enable them to build a foundation of mathematics concepts before entering higher grades where language becomes more "decontextualized and cognitively demanding" (Cummins, 1992). Research shows that "skills in content areas like mathematics and social studies, once learned in the first language, are retained when instruction shifts to the second language," says James Crawford (1995)

In addition, the teachers used methods and strategies to challenge their students to master the academic English of mathematics. Traditionally, mathematics has been thought of as an area with minimal language demands. In fact, mathematics and

language are intricately connected— language facilitates mathematical thinking (Dale & Cuevas, 1992). The teachers in this study embraced today's emphasis on problem solving and communication in mathematics so that their students could master the basic language of mathematics. The language of mathematics includes specialized vocabulary and discourse features (Kang & Pham, 1995). It also incorporates “everyday vocabulary that takes on a different meaning in mathematics,” like equal, rational, irrational, column, and table (Dale & Cuevas, 1992).

There does not appear to be a single right way to engage students with the mathematics content. However, giving students experience with phenomena, making real-world connections, playing games that focus on important learning goals, and using contrived contexts to engage the learners were all effective strategies.

The culture of the mathematics classroom appeared to be a key factor in student learning. Lessons that were rated high had learning environments that were simultaneously respectful of students' backgrounds and culture and challenging for all students and especially for ELLs.

Academic backgrounds of the mathematics teachers contribute to higher student achievement

In this section, I draw conclusions based on the findings for research question 2: *what effect does the academic background and professional development of mathematics teachers in this cross case study have on the academic achievement of second language?*

The participants took different path toward becoming a mathematics teacher. Jesus had a major in mathematics and a minor in science; Jorge had a degree in electrical engineering major, and María had an elementary education major with a minor in

mathematics. While Jesus and María had taken coursework in pedagogy and had completed student teaching requirements prior to becoming teachers, Jorge had been part of an alternative certification program and taught as he learned pedagogy.

The teachers' academic backgrounds were linked with the TAKS proficiency rates of the all student subgroup and the ELLs in the teachers' classrooms. Student achievement data suggests a positive relationship between having a math major in mathematics and coursework in pedagogy and student test scores.

The three participants attended professional development in mathematics content, strategies for teaching English language learners and other sessions in methodologies or pedagogy. The participant background form and interviews confirmed a variance in number of professional development hours attended by the participants. However no correlation was revealed between professional development and student achievement.

Students of teachers certified in mathematics outperform peers taught by teachers without certification (Darling- Hammond, 1999; Fuller & Alexander, 2004; Neild, Farley- Ripple, & Byrnes, 2009; Richardson, 2009). Of the three participants, Jesus had attended a university with the intention of teaching mathematics at the secondary level. He took advanced mathematics coursework and mathematics pedagogy courses that led to his certification in secondary mathematics.

Kukla-Acevedo (2007); Monk (1994); and Weglinsky (2000) found a positive correlation between the number of mathematics courses and greater student achievement. Monk (1994) also found that additional undergraduate mathematics courses do positively impact achievement for students in advanced courses. The Monk (1994) study supports the relevance of Jorge's background in mathematics for his ELLs proficiency on the

mathematics TAKS outscored María's students. While both María and Jorge were both certified to teach middle school mathematics, Jorge had extensive coursework in mathematics and María had eighteen undergraduate hours in mathematics coursework.

Specific professional development sessions that mathematics teachers attend contribute to higher student achievement is supported by teachers' comments and observations

Research shows that professional development leads to better instruction and improved student learning when it connects to the curriculum materials that teachers use, the district and state academic standards that guide their work, and the assessment and accountability measures that evaluate their success.

The teachers in this study commented that the professional development often related to the lessons they were teaching. In some cases they were asked to take their CSCOPE curriculum scope and sequence, timelines, textbooks, and data from students' previous state exam or district benchmark. Jesus noted that professional development presented by fellow teachers deepen his experience for he was allowed opportunities to reflect with colleagues, study what does and does not work in the classrooms, and expand his content and instructional repertoires through ongoing professional development (Smith, 2001). María and Jorge explained that professional development that helped them develop content and pedagogical content knowledge and skills was important in building capacity.

The findings from this study are similar to those of previous studies. The importance of offering professional development that develops teachers' content and pedagogical content knowledge and skills is supported by studies by Cohen & Hill, 2000; Loucks-Horsley, Love, Stiles, Mundry, & Hewson, 2003; and Ball & Cohen, 1999.

Implications

Implications are presented based on the conclusions summarized in the previous section. The implications are grounded on the overall results of the analysis of data presented earlier: lesson plans, observations/lesson implementation, classroom culture, professional development, and mathematics teacher academic background. The implications are grouped into three sections implications for university teacher preparation programs, implications for school administrators, and implications for mathematics teachers.

Implications for University Teacher Preparation Programs

Implications for university teacher preparation programs are linked to Conclusion 4: the academic backgrounds of the mathematics teachers contribute to higher student achievement. In this study, I used the seventh grade mathematics TAKS as a measure of student learning. I also reviewed lessons, teacher academic backgrounds and professional development, observed the implementations of the lessons, and rated classroom culture. The state mandated tests do track what individual teachers are expected to teach their students in seventh grade mathematics, so while limited, they do provide useful outcome-based information for making some connections between teacher effectiveness to teacher preparation programs.

(1) Teacher preparation programs should be judged in large measure on the extent to which teachers prepared by these programs are able to produce gains in students' knowledge and skills commensurate with what they are expected to know and be able to do

Evaluating teacher training programs based, at least in part, on the performance of their trainees has emerged as an education reform strategy in several states and was a central tenet of the Race to the Top grant competition. Much of the existing academic

literature on teacher preparation has focused on differences in the effectiveness of teachers who enter the profession through alternative versus traditional pathways (Glazerman et al., 2006; Goldhaber and Brewer, 2000; Xu et al., 2007). Researchers have only recently used administrative databases to draw the link from teacher preparation programs to in-service teachers and then to student achievement in order to draw conclusions about the efficacy of different teacher training programs (Harris & Sass, 2007; Boyd et al., 2009; Noell Porter, Patt, & Dahir, 2008 ; Henry, Thompson, Bastian, Kershaw, Purtell, and Zulli, 2011).

(2) Universities should ensure that programs prepare students in both the content area they will teach and the pedagogy they need to teach the content

Variation in the training of two mathematics teachers who selected to obtain a teaching certification through a program of study that included a student teaching segment and the teacher with no pedagogy background that decided on certification through an alternative certification route were found. The relationship between student achievement and teacher coursework has also been evaluated, and empirical evidence to support this correlation is reported by documented research. Rice (2003), states the following:

Teacher coursework in both subject area taught and pedagogy contributes to positive education outcomes. Pedagogical coursework seems to contribute to teacher effectiveness at all grade levels, particularly when coupled with content knowledge. The importance of content coursework is most pronounced at the high school level.

Also apparent contradictions about the value of lengthy subject matter preparation might be explained by differences in what is meant by a subject matter major or by

variations in course quality. For example, Jesus majored in mathematics and had taken courses designed to lead to a career in secondary mathematics education. María had chosen a career track that would allow her to teach upper elementary and middle school mathematics. Jorge had elected a career in engineering and had not considered teaching until changes in the economy forced a career change. The type and depth of the course work taken by the teachers had immense differences, yet the three participants taught the same content area.

(3) Teacher education programs can also prepare prospective teachers to teach ELLs by requiring them to spend time in schools and classrooms where they will have contact with ELLs during fieldwork courses and field-work requirements in regular courses

Without such contact, ELLs will remain an abstraction, defined by their lack of proficiency in English and likely to be perceived through prevalent media stereotypes of immigrants. Direct contact allows future teachers to see ELLs as individuals, and it gives the teachers-to-be a sense of the diversity among ELLs—diversity of languages, cultures, native countries, personalities, and academic back- grounds and abilities.

Implications for School Administration

This study found a correlation between the mathematic teachers' academic mathematics background such as mathematics content-area education, and type of certification and student achievement on the seventh grade mathematics TAKS. The correlation is linked to Conclusion 4: the academic backgrounds of the mathematics teachers contribute to higher student achievement. The findings of this study imply that the teacher quality, represented by type of university degree, teacher content-area certification in mathematics, and teacher interaction with students are important factors in

predicting mathematics proficiency for middle school students particularly second language learners.

(4) School district administrators should focus on hiring teachers who have college majors in the area of their assignment and content-area certification in mathematics in order to increase students' proficiency on state mandated exams

The student proficiency rates for Jesus and Jorge's classrooms were higher than those of María's students. An analysis of transcripts revealed that both Jesus and Jorge had extensive course in mathematics while María had only eighteen college hours in mathematics. Current evidence suggests that teacher certification in content specific areas has a positive effect on student achievement. Goldhauber et al., (1996) report "teachers certified in mathematics and those with Bachelors' or Masters' degrees in mathematics and science were associated with higher student performance in those areas." In a more recent finding by Rice (2003),

Research has demonstrated a positive effect of certified teachers on high school, mathematics achievements when the area of certification is mathematics. Studies show little clear impact of emergency or alternative-route certification on student performance in either mathematics or science, as compared to teachers who acquire standard certification.

(5) District administrators should be vigilant of the type of professional development offered to mathematics teachers of ELLs

To meet the needs of English language learners, it is essential to clearly identify not only disciplinary or conceptual goals, but also academic and linguistic goals (Walqui & van Lier, 2010).

Conceptual goals emerge from the discipline of mathematics, and are often

associated with the conceptual understanding and procedural fluency that underpin teaching mathematics for understanding (Kilpatrick, Swafford, & Findell, 2001). Academic goals are generative and span multiple school disciplines. These usually require higher order thinking: generalizing, synthesizing, and comparing and contrasting. These academic goals are aligned with both the National Council of Teachers of Mathematics Process Standards as well as the Standards for Mathematical Practice from the Common Core State Standards in Mathematics. For instance, to “model with mathematics” students need to engage in generating, applying, testing, and revising mathematical representations as they relate to real-world scenarios. Linguistic goals can be considered on two levels. At a broad level, each unit, lesson, and task has specific language functions or genres as its objectives. For example, comparison and contrast is a language function that applies not only to mathematics but any academic discipline. Providing counterexamples is a language function that is more specific to mathematics. This approach to language views proof, for instance, as a specific genre with its own rules, conventions, and structures about which students need explicit instruction. Further, the genre of proof itself has subgenres: a proof by contradiction reads differently than a constructive proof or an existence proof. These differences can be understood in terms of language functions

(6) Campus administrators must become cognizant of content area assignments, staff development content and follow-up, and lesson planning and lesson implementation

First, campus administrators should ensure that teachers are assigned the appropriate teaching subjects. For teachers who do not have college majors in their content area, campus administrators should provide measures to encourage teachers to

return to post secondary education while teaching or offer appropriate professional development.

Additionally, school administrators should ensure that teachers attend substantial professional development sessions that are a minimum of at least 49 hours, are presented by an individual with credentials rather than through a “train-the-trainer” approach, and organize workshops or summer institutes that vary in duration and intensity.

Implementing applicable professional development support will lead to student achievement results as indicated in Conclusion 5: specific professional development sessions that mathematics teachers attend contribute to higher student achievement.

(7) School administrators must have a system in place that allows them to monitor the variability among teachers

What is necessary is a comprehensive system that gives teachers the guidance and feedback, supportive leadership, and working conditions to improve their performance, and that permits schools to remove persistently ineffective teachers without distorting the entire instructional program by imposing a flawed system of standardized quantification of teacher quality.

(8) Campus administrators must also minimize the impact of ineffective teachers

Examining existing policies for placing students with teachers deserves serious study to ensure that various subpopulations are not being subjected to systematic inequity across grades because they are assigned systematically to less effective teachers. Studies have found that children who are taught by several ineffective teachers in a row tend to perform less well than similar students who are taught by several more effective teachers in a row (Sanders & Rivers, 1996). And earlier research suggesting that schooling cannot overcome the effects of students’ background has shown to be fatally flawed (Whitehurst,

2002). If ineffective teachers are disproportionately assigned to a school within a district, the children who have these teachers quite possibly are not receiving an opportunity to get a good education.

Implications for Teachers

This study validated that mathematics teachers simultaneously promote higher student learning when they: adapt lessons to the needs of their students develop lessons that result in higher student achievement (Conclusion 1); include literacy strategies in their lessons help students achieve higher proficiency (Conclusion 2); and create a respectful and challenging learning environment (Conclusion 3).

(9) Mathematics teachers should learn and implement teaching and learning strategies that support literacy development and enhance the understanding of mathematics concepts

The acquisition of different types of knowledge, skill, and levels of thinking is supported by Bloom (1956). Merrill (1971) adds that acquisition requires different conditions of learning that in turn call for different methods of teaching to produce efficient and effective instruction. It is not a matter of preference what teaching and learning strategies to use to meet a particular set of objectives, but it is a matter of making informed pedagogical choices.

Teachers who are effective have been shown to establish classroom spaces that are truly conducive to sharing (Conclusion 3). They work at developing interrelationships that create cognitive and physical spaces for students to develop their mathematical and cultural identities. In classroom arrangements, creating such spaces depends a great deal on creating a hospitable environment that makes it possible to reason, communicate, reflect on, and critique ideas. It also depends on creating opportunities for students to do

this through classroom discussion. Teachers who work toward an outcomes-based agenda emphasize purposeful and thoughtful discourse and provide opportunities for sharing this in the classroom.

(10) Teachers should take heart that in providing opportunities for students to explore mathematics through a range of discursive contexts they contribute to the enhancement of social and cognitive engagement

The most effective settings provide a balance between opportunities for students to benefit from teacher telling and students' involvement in discussion and debate. The activities that teachers plan, and the sorts of mathematical discussions that take place around those activities, are crucially important to learning. Effective teachers plan their classroom discussions with many factors in mind, including the individual student's knowledge and experiences and the participation norms established in the classroom. As teachers reflect on these elements of effective instruction and work with their colleagues to refine their instructional practices, they can impact their students' learning and growth in reading achievement. Several studies have shown that the more teachers incorporate higher order talk and writing about text, strategy instruction, a student-support stance, and active responding, the more growth and achievement their students demonstrate on standardized reading tests (Taylor, Pearson, Peterson, & Rodriguez, 2002, 2003, 2005).

(11) Mathematics teachers must not only know their subject, they must understand and implement literacy strategies in their diverse classrooms

Additionally, this study demonstrated that preparation in pedagogy is also beneficial. Evidence of positive associations to coursework in subject-specific methods also supports this view. In mathematics, there is evidence of a positive relationship between subject-specific certification (which includes both work in content and pedagogy) and student achievement at the secondary level (Goldhaber & Brewer, 19776;

Hawk, Cobble, and Swanson, 1985). The outcomes of this research not only support leading professional organizations that advocate a closer link between content and pedagogy in the preparation of teachers (Conference Board of the Mathematical Sciences, 2001; Ferrini-Mundy & Findell, 2001) but the National Mathematics Advisory Panel claim that “Teachers’ mathematical knowledge is important for students’ achievement.” One of the practical implications of this study is that it suggests placing targeted emphasis on the development of teachers’ knowledge of concepts and literacy while providing content-focused and second language acquisition professional development specifically designed to improve student achievement and literacy. However, to study more mathematics is helpful only if teachers are learning the mathematics in ways that will help them help their students learn more mathematics (Ball, 2003).

Improving teacher quality is the mutual responsibility of school administrators, policy makers, and teachers. Teachers and administrators are in a better position to ensure that all students have appropriate learning opportunities.

Limitations

The first limitation of this cross cases study is the small number of participants. As a result future research with a larger sample in multiple middle school settings needs to be carried out to validate the findings presented here.

A second limitation is the weakness of using only one year of student test data to measure teaching effectiveness for teachers in this study. Data for each teacher’s students over several years would provide a stronger evidence base.

A third limitation is that this study measured teacher effectiveness on student test score data without considering other factors that affect test scores. A number of factors

have been found to have strong influences on student learning gains. These include the influences of students' other teachers—both previous teachers and, in secondary schools, current teachers of other subjects—as well as tutors or instructional specialists, who have been found often to have very large influences on achievement gains (Rothstein, Ladd, Baker, Barton, Darling-Hammond, Haertel, Linn, Shavelson, and Shepard, 2010).

Conclusion

The present cross case analysis investigated the instructional practices middle school mathematics teachers use in classes with English language learners. The data gathered, lesson plans, observations, interviews, records of the academic background and professional development sessions and students' scores on a state mandated mathematics exam, was analyzed and yielded answers to the two research questions posed in this study: *Research Question 1 What instructional practices do middle school mathematics teachers in this cross case study use in classes with ELLs? Sub-question: How do the different practices result in differential student achievement between mainstream students and ELLs? Research Question 2 What effect does the academic background and professional development of mathematics teachers in this cross case study have on the academic achievement of second language learners?*

The following were the findings from this study: (1) the three participants selected content based on characteristics of the students, particularly those of their English language learners; (2) the quality of lessons the teachers designed and taught to help English language learners learn mathematics content while simultaneously learning language varied considerably among the three participants; (3) the majority of lessons received high ratings for intellectual rigor, constructive criticism, and evidence of

challenging of ideas and having a climate of respect for students' ideas, questions and contributions; (4) two participants had taken coursework in pedagogy and had completed student teaching requirements prior to becoming teachers, the third had been part of an alternative certification program and taught as he learned pedagogy; (5) while there were variances in the amount and type of professional development attended, there was no indication of a correlation between professional development and student achievement; and (6) academic background data suggests a positive relationship between having a math major in mathematics and coursework in pedagogy and student test scores. The findings of this study imply that the teacher quality, represented by type of university degree, teacher content-area certification in mathematics, and teacher interaction with students are important factors in predicting mathematics proficiency for middle school students particularly second language learners.

The findings summarized in this research offer practical evidence that secondary mathematics teachers can successfully teach English language learners as well as mainstream students higher cognitive processes and literacy simultaneously. It also validates that instructional methods that are derived from current sociocultural theories are practical and workable in modifying the learning processes that take place within mathematic classrooms with diverse populations.

Based on the findings, I drew the following conclusions: (1) teachers who adapt lessons to the needs of their students develop lessons that result in higher student achievement; (2) mathematics teachers who include literacy strategies in their lessons help students achieve higher proficiency; (3) effective teachers adapt implementation of the standard lesson plans to meet the needs of their students; (4) teachers who create a

respectful and challenging learning environment simultaneously assist students in learning; and (5) teachers' academic background does make a difference in student achievement. It is reasonable to conclude that when teachers are academically prepared in their content areas, their instruction is more effective. The pattern of teacher effects identified in the current study tentatively suggests that the measurement of student outcome rates is a promising avenue for identifying relationships between teacher characteristics and student academic performance. However, future research that better measures the complex and dynamic nature of the mathematics classroom will be necessary to further our understanding of the characteristics and practices of teachers that promote student achievement.

Therefore, the observed advantage of the sociocultural instruction in the mathematics classroom may have been due to the teachers' determination to modify the curriculum and implement strategies learned through professional development sessions to deliver the appropriate instruction to their English language learners. To shed further light on the strengths and weaknesses of various approaches to mathematics instruction, researchers will have to undertake a series of comprehensive program evaluations that monitor teacher preparation and classroom practice (e.g., Senk & Thompson, 2003).

Based on the conclusions, eleven implications for university teacher education programs, school district and campus administrators, and mathematics teachers were found. Implications for university teacher education programs included: (1) teacher preparation programs should be judged in large measure on the extent to which teachers prepared by these programs are able to produce gains in students' knowledge and skills commensurate with what they are expected to know and be able to do; (2) universities

should ensure that programs prepare students in both the content area they will teach and the pedagogy they need to teach the content; and (3) teacher education programs can also prepare prospective teachers to teach ELLs by requiring them to spend time in schools and classrooms where they will have contact with ELLs during fieldwork courses and field-work requirements in regular courses.

Implications for school districts and school personnel are numerous. Professional administrators have the right and the responsibility to help all teachers become as effective as possible in teaching diverse students. The five implications for school personnel found in this study can have a significant impact on the achievement of English language learners in our schools. Implications for school district administrators comprise of following two implications: (4) school district administrators should focus on hiring teachers who have college majors in the area of their assignment and content-area certification in mathematics in order to increase students' proficiency on state mandated exams; (5) district administrators should be vigilant of the type of professional development offered to mathematics teachers of ELLs; (6) campus administrators must become cognizant of content area assignments, staff development content and follow-up, and lesson planning and lesson implementation; (7) school administrators must have a system in place that allows them to monitor the variability among teachers; and (8) campus administrators must also minimize the impact of ineffective teachers.

Three implications for teachers of mathematics were established. For mathematics teachers the implications are critical to the success of diverse students: (9) mathematics teachers should learn and implement teaching and learning strategies that support literacy development and enhance the understanding of mathematics concepts; (10) teachers

should take heart that in providing opportunities for students to explore mathematics through a range of discursive contexts they contribute to the enhancement of social and cognitive engagement; and (11) mathematics teachers must not only know their subject, they must understand and implement literacy strategies in their diverse classrooms.

Given the current reform in school curriculum and demographic changes indicating that student diversity will continue to grow (National Clearinghouse for English Language Acquisition, 2011), educational practitioners, administrators, and teachers should be deeply concerned with instructional methods appropriate for second language learners. Teacher academic background, types of professional development sessions offered, and literacy strategies implemented in a secondary mathematics classroom require serious consideration for impacting student achievement.

Middle school is a pivotal point in a student's career. We must provide students with limited English proficiency the same number of learning opportunities we provide to their English-proficient counterparts; academic achievement depends on sufficient opportunities to learn. Poor academic achievement manifests itself in high levels of student dropouts and, frequently, subsequent economic and societal disadvantage, making improving educational attainment for English language learners a societal imperative.

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APPENDIX A

Participant Background

Teacher: _____ Date: _____

Section A. Basic Descriptive Information

Please check one answer choice

Teacher Gender: ☐ Male ☐ Female

Teacher Ethnicity: ☐ American Indian or Alaskan Native

☐ Asian

☐ Hispanic or Latino

☐ Black or African-American

☐ Native Hawaiian or Other Pacific

Level of university degrees earned: B.A. B.S. M.A.

Major: _____

Minor: _____

Certifications: _____

Years of Mathematics Teaching Experience: _____

Please indicate with a check mark the types of professional development that is provided or encouraged by the district.

1. Teaching Mathematics Strategies ☐
2. Teaching Mathematics to English language learners ☐
3. Bilingual/ESL Strategies ☐
4. SIOP (General) ☐
5. SIOP for Mathematics ☐
6. Other (please specify) _____

Professional development attended outside of the campus or district:

1. _____
2. _____
3. _____
4. _____

How many hours of professional development do you attend each year?

☐ 0-6 hours

☐ 7-12 hours

☐ 13-18 hours

☐ more than 18 hours

Professional development workshop that addressed the needs of English language learners (ELLs) in mathematics classrooms:

1. _____
2. _____
3. _____
4. _____
5. _____

How many hours of professional development for addressing the need of ELLs in mathematic classes do you attend each year?

- ___ 0-6 hours
___ 7-12 hours
___ 13-18 hours
___ more than 18 hours

APPENDIX B

LESSON PLAN RUBRIC

1. Copies of instructional materials ☐ Yes ☐ No

| | |
|--|--|
| <p>Section B. Purpose of the Lesson:</p> <p>This section is intended for the indicating how lesson time was spent and to provide the teacher's stated purpose for the lesson.</p> | |
| <p>1. According to the teacher, the purpose of this lesson was:</p> | |
| <p>2. The focus of this lesson is best described as: (Check one.)</p> | |
| <input type="checkbox"/> | Almost entirely working on the development of algorithms/facts/vocabulary |
| <input type="checkbox"/> | Mostly working on the development of algorithms/facts/vocabulary, but working on some mathematics concepts |
| <input type="checkbox"/> | About equally working on algorithms/facts/vocabulary and working on mathematics concepts |
| <input type="checkbox"/> | Mostly working on mathematics/science concepts, but working on some algorithms/facts/vocabulary |
| <input type="checkbox"/> | Almost entirely working on mathematics concepts |
| <p>Section C. Lesson Ratings The researcher will rate each key indicator in four different categories, from 1 (not at all) to 5 (to a great extent). Additional indicators will be included if considered important in capturing the essence of the lesson. Important factors that are determined to be influential in determining a synthesis ratings and specific examples and/or quotes to illustrate those factors will be indicated in the "Supporting Evidence for Synthesis Ratings". The "Don't know" and/or "N/A" will be used in instances when the lesson may not provide evidence for an indicator or when the indicator is inappropriate given the purpose and context of the lesson. This section also includes ratings of the likely impact of instruction and a capsule rating of the quality of the lesson</p> | |

| I Design | | | | | | | | |
|------------------------------|---|------------|---|-------------------|---|------------|-----|---|
| A. Ratings of Key Indicators | | Not at all | | To a great extent | | Don't Know | N/A | |
| 1. | The design of the lesson incorporated tasks, roles, and interactions consistent with investigative mathematics. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 2. | The design of the lesson reflected careful planning and organization. | | | | | | | |
| 3. | <i>*The instructional strategies and activities used in</i> | | | | | | | |

| | | | | | | | |
|---|--|--|--|--|--|--|--|
| <i>this lesson reflected attention to students' experience, preparedness, prior knowledge, and/or learning styles.</i> | | | | | | | |
| 4. The resources available in this lesson contributed to accomplishing the purposes of the instruction. | | | | | | | |
| 5. <i>*The instructional strategies and activities reflected attention to issues of access, equity, and diversity for students (e.g., cooperative learning, language-appropriate strategies/materials).</i> | | | | | | | |
| 6. <i>*The design of the lesson encouraged a collaborative approach to learning among the students.</i> | | | | | | | |
| 7. <i>*Adequate time and structure were provided for "sense-making."</i> | | | | | | | |
| 8. <i>*Measurable language and content objectives were visible in the classroom</i> | | | | | | | |
| 9. <i>*Adequate time and structure were provided for wrap-up.</i> | | | | | | | |
| 10. <i>*Explicit listing of key vocabulary was evident in the classroom</i> | | | | | | | |
| <i>List strategies specifically targeting English language learners</i> | | | | | | | |

B. Synthesis Rating

| 1 | 2 | 3 | 4 | 5 |
|--|---|---|---|---|
| <i>Design of the lesson not at all reflective of best practices for teaching mathematics concepts to ELLs.</i> | | | | <i>Design of the lesson extremely reflective of best practices for teaching mathematics concepts to ELLs.</i> |

C. Supporting Evidence for Synthesis Rating The researcher will provide a brief description of the nature and quality of this component of the lesson, the rationale for the synthesis rating, and evidence to support that rating.

APPENDIX C

LESSON OBSERVATION RUBRIC

Observation Date:_____ Time: Start:_____ End:_____

School: _____Teacher:_____

Section A. Basic Descriptive

2. Students: _____Number of Males _____Number of Females

| I. Implementation | | | | | | | | |
|--|------------|---|---|-------------------|---|------------|-----|--|
| A. Ratings of Key Indicators | Not at all | | | To a great extent | | Don't Know | N/A | |
| 1. The instructional strategies were consistent with investigative mathematics | 1 | 2 | 3 | 4 | 5 | 6 | 7 | |
| 2. The teacher appeared confident in his/her ability to teach mathematics | | | | | | | | |
| 3. <i>*The teacher's classroom management style/strategies enhanced the quality of the lesson</i> | | | | | | | | |
| 4. <i>*The pace of the lesson was appropriate for the developmental levels/needs of the students and the purposes of the lesson.</i> | | | | | | | | |
| 5. The teacher was able to “read” the students’ level of understanding and adjusted instruction accordingly. | | | | | | | | |
| 6. <i>*The teacher, where appropriate, used models or manipulatives to demonstrate concepts and/or processes.</i> | | | | | | | | |
| 7. <i>*The teacher’s questioning strategies were likely to enhance the development of student conceptual understanding/problem solving (e.g., emphasized higher order questions, appropriately used “wait time.” identified prior conceptions and misconceptions).</i> | | | | | | | | |
| 8. <i>*The teacher Think-Alouds technique to narrate the problem-solving process (including algorithms).</i> | | | | | | | | |
| 9. <i>*The teacher used informal language to</i> | | | | | | | | |

| | | | | | | | |
|--|--|--|--|--|--|--|--|
| <i>increase understanding and demonstrate the various thought processes and steps to follow in solving a problem.</i> | | | | | | | |
| <i>10. *The teacher used clarity checks to check for understanding of the task and processes involved before students get started working on the assignment.</i> | | | | | | | |
| <i>11. *The teacher presented activities that involve application problems in contextualized situations. These activities encouraged critical thinking and reasoning along with basic skills development and practice.</i> | | | | | | | |
| <i>12. *The teacher encouraged the use of diagrams and other visual aids to help students develop concepts and understanding.</i> | | | | | | | |
| 13. _____ | | | | | | | |

B. Synthesis Rating

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|--|
| <i>Implementation of the lesson not at all reflective of best practices for teaching ELLs in mathematics classrooms</i> | | | | <i>Implementation of the lesson extremely reflective of best practices for teaching ELLs in mathematics classrooms</i> |

C. Supporting Evidence for Synthesis Rating

The researcher will provide a brief description of the nature and quality of this component of the lesson, the rationale for the synthesis rating, and evidence to support that rating.

A. Lesson Arrangements and Activities

In question 1 of this section, please divide the total duration of the lesson into instructional and noninstructional time. In question 2, the researcher will make estimates based only on the *instructional time* of the lesson.

1. Approximately how many minutes during the lesson were spent:

- On instructional activities? _____ minutes
- On housekeeping unrelated to the lesson/interruptions/other non-instructional activities? _____ minutes

Describe:

- c. Check here if the lesson included a major interruption (e.g., fire drill, assembly, shortened class period):
2. Considering only the *instructional time* of the lesson (listed in 1a above), approximately what percent of this time was spent in each of the following arrangements?
- | | |
|-----------------------|--------------|
| a. Whole class | _____ % |
| b. Pairs/small groups | _____ % |
| c. Individuals | _____ % |
| | _____ |
| | 100 % |

APPENDIX D Classroom Culture Rubric

Observation Date: _____ Time: Start: _____ End: _____

School: _____ Teacher: _____

| B. Ratings of Key Indicators | Not at all | | | | | To a great extent | Don't Know | N/A |
|---|------------|---|---|---|---|-------------------|------------|-----|
| 11. <i>*Active participation of all was encouraged and valued</i> | 1 | 2 | 3 | 4 | 5 | 6 | 7 | |
| 12. <i>*There was a climate of respect for students' ideas, questions, and contributions.</i> | | | | | | | | |
| 13. <i>*Interactions reflected collegial working relationships among students (e.g. students worked together, talked with each other about the lesson).</i> | | | | | | | | |
| 14. <i>*Interactions reflected collaborative working relationships between teacher and ELLs.</i> | | | | | | | | |
| 15. <i>*The climate of the lesson encouraged ELLs to generate ideas, questions, conjectures, and/or propositions.</i> | | | | | | | | |
| 16. <i>*Intellectual rigor, constructive criticism, and the challenging of ideas were evident.</i> | | | | | | | | |
| 17. <i>*The experiences and cultures of ELLs are valued.</i> | | | | | | | | |
| 18. <i>*ELLs are allowed to record answers or solution steps in their own native language.</i> | | | | | | | | |
| 19. <i>*Focus is placed on the meanings ELLs are conveying instead of on grammar and usage.</i> | | | | | | | | |
| 20. _____ | | | | | | 6 | 7 | |

C. Synthesis Rating

| | | | | |
|--|---|---|---|--|
| 1 | 2 | 3 | 4 | 5 |
| <i>Classroom culture interfered with ELL student learning.</i> | | | | <i>Classroom culture facilitated the learning of ELLs.</i> |

D. Supporting Evidence for Synthesis Rating

- E. The researcher will provide a brief description of the nature and quality of this component of the lesson, the rationale for the synthesis rating, and evidence to support that rating.

APPENDIX E

PARTICIPANT INTERVIEW QUESTIONS

Mathematics Teacher_____ **Date:**_____

| | |
|---|---|
| 1 | What is the purpose of the lesson? |
| 2 | Do you use think-aloud techniques to narrate the problem-solving processes? If so has it been successful for ELLs? |
| 3 | What type of background do you have to teach ELLs in a mainstream mathematics classroom? |
| 4 | What type of support do you receive in teaching mathematics concepts to ELLs? |
| 5 | What types of strategies do you implement to assist English language learners obtain a mathematical concept? |
| 6 | Do you use informal language to increase understanding and demonstrate the various thought processes and steps to follow in solving a problem? If so, please discuss. |
| 7 | Do you use the Spanish language during instruction? Why/why not? |

| | |
|---|---|
| 8 | Do you provide mathematical terminology in Spanish for ELLs? |
| | OPEN-ENDED DISCUSSIONS |
| | Address success stories in helping second language learners with mathematical concepts and language acquisition. |
| | Discuss experiences with mathematic problems particularly the difficulty of teaching mathematical concepts to second language learners. |
| | Explain how you integrate vocabulary into the lesson. Activities, games, etc. |

APPENDIX F

Discipline Literacy in the Secondary Mathematics Classroom Research Study Teacher Consent Form

You are being asked to take part in a research study of incorporating discipline literacy in the secondary mathematics classroom. Through this study, the research hopes to learn what pedagogies work well in the mathematics classroom with English language students, what types of professional development that centers on strategies particularly for English language learners do seventh grade mathematics teachers participate in, and how does specific academic background makes a difference in the mathematics classroom. You must currently be teaching seventh grade mathematics to participate in this study. Please read this form carefully and ask any questions you may have before agreeing to take part in the study.

What the study is about: The purpose of this study is to determine the pedagogical and instructional practices and types of professional development middle school mathematics teachers need to be effective in meeting the needs of English Language Learners in the mathematics classroom. Additionally, this study proposes to examine the effects of mathematics teachers' academic background on the academic achievement of second language learners through case studies of five middle school mathematics teachers in a school district in close proximity to the Texas/Mexico border.

What we will ask you to do: If you agree to be in this study, the researcher will conduct an interview with you. The interview will include questions about your current teacher position, the number of students in your classes, the composition of your classes, your academic background and certifications. The interview will take about 30 minutes to complete. With your permission, we would also like to tape-record the interview. Data on the behaviors within the context of the mathematic classrooms will be collected through participant observations. Observations will be conducted on a weekly basis with the researcher visiting classrooms in forty-five minute segments during the semester. To facilitate the process, the researcher will meet with the teacher one or two days prior to the observation for a fifteen minute discussion of the lesson objectives, classroom composition: number and demographics of students, i.e., ethnicity, gender, LEP, special education services, etc., the lesson, resources, classroom structure.

Risks and benefits:

I do not anticipate any risks to you participating in this study other than some teachers may feel some discomfort with the researcher's presence in the classroom during instruction. Once the study is completed, findings will be shared with the district administrators and teachers who participated.

Compensation: There is no compensation in participating with this study.

Your answers will be confidential. The records of this study will be kept private. In any sort of report made public we will not include any information that will make it possible

to identify you. Research records will be kept in a locked file; only the researcher will have access to the records. If the interviews are tape-recorded, the tape will be destroyed after it has been transcribed, which is anticipated to be within two months of its taping.

Taking part is voluntary: Taking part in this study is completely voluntary. If you decide not to take part, it will not affect your current or future relationship the researcher. If you decide to take part, you are free to withdraw at any time.

If you have questions: The researcher conducting this study is Sandra Quiroz. Please ask any questions you have now. If you have questions later, you may contact Sandra Quiroz at sandra.sotoquiroz@gmail.com or at 956-588-7359. If you have any questions or concerns regarding your rights as a subject in this study, you may contact the Institutional Review Board (IRB) at _____ or access their website at _____. You may also report your concerns or complaints anonymously through or by calling toll free at _____. You will be given a copy of this form to keep for your records.

Statement of Consent: I have read the above information, and have received answers to any questions I asked. I consent to take part in the study.

Your Signature _____ Date _____

Your Name (printed) _____

In addition to agreeing to participate, I also consent to having the interview tape-recorded.

Your Signature _____ Date _____

Signature of person obtaining consent _____ Date _____

Printed name of person obtaining consent _____ Date _____

This consent form will be kept by the researcher for at least three years beyond the end of the study and was approved by the IRB on [date].

APPENDIX G

Superintendent of Schools Consent Form

I am conducting research on the integration of disciplinary literacy in the secondary mathematics classroom. The purpose of this study is to determine the pedagogical and instructional practices and types of professional development middle school mathematics teachers need to be effective in meeting the needs of English Language Learners in the mathematics classroom. Additionally, this study proposes to examine the effects of mathematics teachers' academic background on the academic achievement of second language learners through case studies of five middle school mathematics teachers in Pharr-San Juan-Alamo ISD.

To complete the research project, the Institutional Review Board requires that I obtain permission from the school district where I will conduct the research. The interview will include questions about the teacher's current teaching position, the number of students in their classes, the composition of their classes, academic background and certifications. The interview will take about 30 minutes to complete. If the teachers consent, interviews will be tape-recorded. Data on the behaviors within the context of the mathematics classrooms will be collected through participant observations. Observations will be conducted in forty-five minute segments during the semester with the researcher visiting classrooms. To facilitate the process, the researcher will meet with the teacher one or two days prior to the observation for a fifteen minute discussion of the lesson objectives, resources, classroom structure, etc.

I do not anticipate any risks to participation other than some teachers may feel some discomfort with the researcher's presence in the classroom during instruction. Once the study is completed, findings will be shared with the district administrators and teachers who participated. The records of this study will be kept private. If any sort of report is made public, participation will be de-identified. Research records will be kept in a locked file; only the researcher will have access to the records. If the interviews are tape-recorded, the tape will be destroyed after it has been transcribed, which is anticipated to be within two months of its taping. Participation in this study is completely voluntary. If teachers select not to take part, it will not affect their current or future relationship with the researcher. Once teachers have decided to participate, they will be free to withdraw at any time.

If you have questions: The researcher conducting this study is Sandra Quiroz. Please contact Sandra Quiroz at sandra.sotoquiroz@gmail.com or at 956-588-7359 if you have any questions.

Statement of Consent: I have read the above information, and have received answers to any questions I asked. I consent to allow Sandra Quiroz conduct the research described in Pharr-San Juan-Alamo ISD.

Superintendent of Schools: _____ Date _____

Name (printed)

This consent form will be kept by the researcher for at least three years beyond the end of the study.

APPENDIX H

Middle School Principal Consent Form

I am conducting research on the integration of disciplinary literacy in the secondary mathematics classroom. The purpose of this study is to determine the pedagogical and instructional practices and types of professional development middle school mathematics teachers need to be effective in meeting the needs of English Language Learners in the mathematics classroom. Additionally, this study proposes to examine the effects of mathematics teachers' academic background on the academic achievement of second language learners through case studies of six middle school mathematics teachers in two Pharr-San Juan-Alamo ISD middle schools.

To complete the research project, the Institutional Review Board requires that I obtain permission from the campus where I will conduct the research. The interview will include questions about the teacher's current teaching position, the number of students in their classes, the composition of their classes, academic background and certifications. The interview will take about 45 minutes to complete. If the teachers consent, interviews will be tape-recorded. Data on the behaviors within the context of the mathematic classrooms will be collected through participant observations. Observations will be conducted in forty-five minute segments during the semester with the researcher visiting classrooms. To facilitate the process, the researcher will meet with the teacher one or two days prior to the observation for a fifteen minute discussion of the lesson objectives, resources, classroom structure, etc.

I do not anticipate any risks to participation other than some teachers may feel some discomfort with the researcher's presence in the classroom during instruction. Once the study is completed, findings will be shared with the district administrators and teachers who participated. The records of this study will be kept private. If any sort of report is made public, participation will be de-identified. Research records will be kept in a locked file; only the researcher will have access to the records. If the interviews are tape-recorded, the tape will be destroyed after it has been transcribed, which is anticipated to be within two months of its taping. Participation in this study is completely voluntary. If teachers select not to take part, it will not affect their current or future relationship with the researcher. Once teachers have decided to participate, they will be free to withdraw at any time.

If you have questions: The researcher conducting this study is Sandra Quiroz. Please contact Sandra Quiroz at sandra.sotoquiroz@gmail.com or at 956-588-7359 if you have any questions.

Statement of Consent: I have read the above information, and have received answers to any questions I asked. I consent to allow Sandra Quiroz conduct the research described in Pharr-San Juan-Alamo ISD.

Campus Principal: _____ Date _____

Name (printed)

This consent form will be kept by the researcher for at least three years beyond the end of the study.